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METEORITES AT THE EXHIBITION.

THE Exhibition contains at least four remarkable meteorites—one from Chihuahua, Mexico, now to be seen in the Mexican section of the main building; one from Ovifak, Greenland, on exhibition at one of the entrances on the northern side of the main building, and two in the Government building,—one from Tucson, Arizona, and one (known as "The Blake") from Tennessee.

The Ovifak (Greenland) meteorite, the heaviest of the specimens on exhibition, weighs 6 20-100 tons, and is one of a group of iron meteorites discovered upon the shores of Greenland by Professor Nordenskjold, the celebrated mineralogist and Arctic explorer, who is also one of the judges in group jury No. 1 at the Exhibition. The discovery was made in 1870, at Ovifak, in Disco Island, upon the open coast, and at a place almost inaccessible in even a moderately rough sea. Says the Philadelphia *Press:* Here were found meteorites of various dimensions which are supposed to have fallen during the tertiary period, an ancient date in the world's history, and had been imbedded in the strata of the miocene period. They have since excited much attention and interest in the scientific world. The cliffs of the place rise to a height of 2000 ft. above the sea-level, the upper portion being formed in basalt. The meteorites were found upon the shore at the base of this cliff, within an area of about fifty square yards. There were twelve large specimens and many smaller ones. In 1871 the Swedish Government fitted out an expedition, composed of two naval vessels under the command of Capt. Baron Von Otter, to go to Baffin's Bay in Greenland and procure these numerous masses of meteoric iron. The second block has been presented to the museum in Copenhagen, and one of the smaller ones is in the British Museum.

The Irwin-Ainsa meteorite, a ring-shaped meteorite from Arizona, sometimes called the signet meteorite, now occupies a place in the Smithsonian department in the Government Building. It was found in the early part of the last century in the Sierra de la Medera Mountains, near Tucson, Arizona Territory. There is a tradition among the old residents of Tucson that there was a shower of meteorites in the mountains there some two hundred years ago. In 1735, Captain Juan Bautiste Ainsa, who then visited the region, undertook to transport this large meteorite to Spain. After getting it as far as Tucson he abandoned the undertaking, and the meteorite remained in that town and was used as a kind of public anvil by the people. It is the only annular meteorite of which there is any record, and is the property of the National Museum at Washington. Its total weight is 1540 pounds. One of the distinguished scientists at the Exhibition inclines to the opinion that the large cavity in the specimen was originally occupied by sulphurous or earthy minerals such as are often found in meteorites in a more or less globular condition, and which by decomposition in the soil leave the iron free and with a pitted surface.

The Blake meteorite in the Government building is a new and interesting specimen, weighing about 300 pounds, brought by General Wilder from Tennessee. It was discovered in 1875 in Cocke County, about ten miles from Greenville, by a farmer, who, after breaking two ploughs upon it, dug it out. It is a compact mass of iron, containing both nickel and cobalt, and no doubt has a very interesting interior structure, as yet undetermined. When found it was standing at an angle of about forty five degrees, the top about eight inches below the surface. It is one of a number of interesting specimens belonging to the private collection of meteoric stones, minerals, etc., of Professor W. P. Blake, in charge of the mineral department of the Smithsonian Institute.

The Chihuahua meteorite, located in the Mexican department of the Main Building, is a compact mass of iron, with a pitted surface, weighing four thousand pounds, and one of several meteorites found at Chihuahua. The exterior of this meteorite very much resembles that of the Arizona specimen.

Dr. Von Baumhauer, of the Netherlands, one of the judges of the Exhibition, who has made extensive and special studies of the constitution of meteorites, and commenced his researches over thirty years ago, expresses the conviction that meteoric iron is in no place the result of igneous fusion, but rather that iron meteorites are the result of deposition from solution, and therefore must have originated in conditions not unlike those which exist upon our own planet as regards temperature, though as respects atmosphere no oxygen probably was present, but rather an atmosphere of hydrogen. In some instances it seems that the deposition of the iron was in layers.

The meteor of the Cape of Good Hope, for example, presents a true stratification in layers or bands arranged one

THE ARIZONA METEORITE AT THE EXHIBITION.

layer above another. These bands of iron do not, however, show any difference of chemical composition. It may be that the interplanetary spaces are filled with meteoric dust and grains ranging in size from mere powder or dust to the largest planets, and Dr. Baumhauer suggests that the auroral displays are caused by the polarization of meteoric dust by the magnetism of the earth. Nordenskjold, it will be remembered, found an impalpable dust of iron upon the broad expanse of the Arctic shows. An examination of this dust resulted in the discovery of the presence of not only iron but of nickel, and its meteoric origin is certain.

The close connection of these meteorites with basalt has led many authorities to suppose that they may be of terrestrial rather than of meteoric origin. It is usual to grind and polish the surfaces of specimens of this iron, and these almost invariably show a very peculiar crystalline structure. This is brought out by etching, some portions of the iron being less acted upon by strong acids than others. Surfaces so etched may be used to print from, and many of the illustrations of the structure of meteorites are printed directly from the meteoric iron plate.

One of the most interesting facts yet discovered with regard to meteorites is the enormous amount of hydrogen gas which they contain. Its presence in meteorites was demonstrated by Graham, and Professor Wright, of Yale College, has published several important memoirs upon the occlusion of hydrogen in meteoric iron. Nearly all the facts point to the absence of oxygen gas in the region where these meteorites originated. Nickel and cobalt are their almost invariable associates, while silver, phosphorus and chlorine are also found in some of the irons.

Of the collections of meteorites, that of the British Museum ranks first in importance, that of Vienna second, of Paris third, and of Professor Charles U. Shepard, of Amherst, Mass., fourth. In the last-named collection no less than 254 localities of meteorites are represented, the total weight of the collection being about 1200 pounds, the heaviest iron weighing 438 pounds, and the lightest half an ounce. The largest meteoric stone in the professor's collection weighs 57¼ pounds, and is from Waconda, Kansas. The collection in the Academy of Natural Sciences of Philadelphia, and that in Yale College, are also of considerable importance. Professor Smith, of Louisville, Ky., who has given much attention to the examination of meteorites, and has published many memoirs upon them, also has a large and interesting collection.

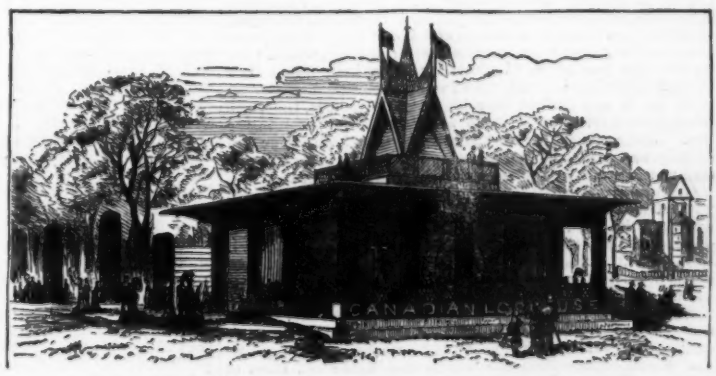
THE GREENLAND METEORITE AT THE EXHIBITION.

THE CANADIAN LOG-HOUSE.

THE Canadian timber exhibits are shown in the form of a log-house, constructed entirely of marketable timber in the log and as sawn planks. The timbers are placed with blocks between them to facilitate a free circulation of the air and the drying of the timbers, which will be worth ten per cent more when ready for removal than they were when the building was erected, the increase of value being due to the drying of the lumber. Our sketch is from *Frank Leslie's Illustrated Newspaper*. The structure, having about 72 feet front, facing the narrow-gauge railroad, and being 56 feet deep, is situated at the southern extremity of the ground assigned to the British villa, and is composed of logs, planks, shingles, laths, and other forms of timber. The roof is supported by six logs in the front, six in the rear, and three at each end. These logs have the bark on, are 16 feet high, and range from 48 down to about 36 inches in diameter, each one being of a different kind of wood. The cornice is of deal planking piled one above the other to a height of five feet, with an outward slope to the verge of the roof, the incline commencing at the top of the vertical logs. The roof is formed of planking which projects over the face of the columns about five feet, the width of the planks being in no case less than 24 inches. At the apex of the roof is a tower composed of planks piled in angular style, to the top of which is fixed a flagstaff. The outer, as well as the inner, walls and stairways are composed of stacked timber, with blocks between each plank. The plan of construction is such that, although unenclosed, it has, when inside of the pillars, all the appearance of a house. There are 12 flights of stairs constructed of planks of all varieties of timber grown within the jurisdiction of what was formerly the Hudson's Bay Company. The appearance inside is that of several rooms and stairways. The structure contains about 102,000 feet, board measure, of planks, boards, and deals. In logs, pillars, and square pieces there are about 90,000 square feet.

The rooms are of different qualities of lumber cut in sections to show the grain, fibre, and age of the trees of which they are specimens. Starting at the southeast corner of the building, the first column is 44 inches in diameter, of yellow pine. The next column on the front is of sugar maple, 38 inches in diameter; the next is an ash 42 inches in diameter, then a birch 39 inches in diameter, and a chestnut at the northeast corner 49 inches in diameter, all of these logs being 16 feet high. The next is a beech 32 inches, followed by a cherry 26 inches in diameter; then follow a hemlock 42 inches, a black walnut 36 inches, a cherry 32 inches, a red cherry 35 inches, a yellow pine 45 inches, a spruce 34 inches, and a maple 30 inches in diameter.

In the west room is a table 4 feet wide, 12 feet long, and 6 inches thick—a single plank of yellow pine—and upon this table are two planks set to form a triangle, one side being of white cedar 4 ft. 9 in., the other side being of white pine, and 4 feet wide; between these is a section of white cedar 4½ feet



THE CANADIAN LOG-HOUSE AT THE EXHIBITION.

in diameter, with the bark on, together with sections of cherry, white pine, white maple, and rosewood.

In the east room are two turned columns standing on a white pine pedestal; these columns are 36 inches in diameter and are 14 feet high. Between these columns is a table, the top of which is formed of a solid piece of white pine 8 ft. 4 in. wide, 9 in. thick, and 16 ft. long, which is the largest piece of timber exhibited. On this table is a section of pine with the bark on, cut from a log 30 ft. long, which could not be transported because of its size. This section shows 664 years' growth, is 8 ft. 5 in. in diameter, and is 3 ft. 9 in. thick, the weight of the section being 7500 lbs. The building contains marketable timber only, and was erected under the supervision of Hippolyte Larochelle, Esq., of St. Anselme, in Quebec, who has been appointed by the Dominion Government as the Commissioner. The whole exhibit is interesting, and undoubtedly the most extensive of any in its line in the Exhibition.

EXHIBITION NOTES.

VULCANIZED FIBRE.

In Machinery Hall is shown a number of samples of the products known as hard and flexible vulcanized fibre, and a variety of articles manufactured therefrom and adapted for general mechanical purposes, etc.; while in the Shoe and Leather Building there is shown a number of trunks, valises, etc., made therefrom.

The pamphlet issued by the Vulcanized Fibre Co., Wilmington, Del., states that vulcanized fibre is a new article of manufacture, consisting of vegetable fibre reduced to a pulp, and then subjected to powerful chemical treatment, whereby the original properties of the fibre are entirely changed, and a new and exceedingly valuable material is produced, which is already largely utilized, and will eventually enter into almost every branch of mechanical industry. The process and different articles made are secured by numerous patents, but the goods are sold at less prices than any competing articles, and in most cases are superior to any thing of a similar nature ever offered. They are made either hard or flexible, as desired, varying in their properties to some extent, according to the uses for which they are intended.

The hard fibre is somewhat like horn in its consistency, is very tough and strong, has remarkable durability under friction, and remains permanently elastic under all ordinary conditions of weather and temperature.

The flexible fibre closely resembles the best English sole leather in appearance, and is largely used as a substitute therefor in mechanical appliances, but is much closer grained and far more durable, and being of uniform quality and thickness throughout, cuts without waste. It is used largely in place of rubber for packing.

The general exhibit in Machinery Hall includes a number of miscellaneous articles, such as napkin rings, martingale rings, tobacco boxes, condenser ferrules, etc., gas and pneumatic conductors, besides a number of articles adapted for general mechanical uses, such as elastic fish-bolt washers, car-box covers, and dust guards, gibs and journal bearings, plumbers' and axle washers, flexible sheet packing, etc., etc.

Concerning the valuable properties of these articles, it is represented that the vulcanized fibre is perfectly insoluble in hot or cold water, oil, naphtha, petroleum, or alcohol, and but slightly affected by most of the acids. It will not absorb oil nor any other fluid except water, and the only effect of water upon it is to cause it to expand and become elastic like leather. For washers in various situations, the vulcanized fibre is affirmed to be at once cheaper than leather and far superior to it in durability, because of its indifference to many agents that speedily rot the latter and render it useless. These washers are said to be rapidly growing in favor, for mechanical, railroad and general machine uses, for which purposes the company supplies the goods cut to order, of any desired pattern or thickness, or furnishes those who desire to cut their own washers with the material in sheets of any thickness. For gibs for cross-heads, etc., the manufacturers furnish hard-rolled goods of suitable length and width, which they assert will be found to be cheaper and more durable than brass, not liable to cut the slides, and very economical of oil.

Being entirely free from grit, and having remarkable anti-friction properties, the vulcanized fibre is further claimed to be well adapted for journal bearings, where there is high speed without too great weight, such as shafting, and other bearings up to two inches in diameter. In these positions it will greatly outwear brass or Babbitt metal, and require only one half the usual lubrication. It is usually applied in the form of a tube for bearings from ⅜ in. to 1¼ in. diameter; and above that size is used in plates ⅛ in. to ¼ in. thick, set edgewise in a brass or iron box, and bored out. The spaces between the plates form receptacles for the oil, which thus renders the bearing self-lubricating for a long time. The tubes are furnished in all sizes from ⅜ in. inside diameter up to 1¼ in. in any desired lengths up to 22 inches, the price being from 4 cents to 10 cents per lineal inch, according to size. These tubes are rolled accurately true, both inside and outside, and need only to be cut off in proper lengths, and clamped between iron boxes, or caps, to be ready for use.

Concerning the flexible sheet fibre, the circular of the company affords the information that "the sheets are made 42 in. wide by 5 ft. 6 in. long, and of any desired thickness from $\frac{1}{64}$ in. to $\frac{1}{16}$ in., but are usually cut into half sheets 21 in. wide by 5 ft. 6 in. long for convenience of shipment. These goods are used for carriage washers, gaskets, water packing, plumbers' fittings, car-box washers (or 'dust guards'), oil-box covers, and a great variety of uses. They are more easily and accurately cut than leather, and being uniform in quality and thickness throughout, there is no waste in cutting, like that which occurs from the 'skirts and flanks' of sides of leather. They are insoluble in and uninjured by hot or cold water, oil, grease, petroleum, gas, turpentine, alcohol, or any of the ordinary solvents, and do not apparently deteriorate by age. While not in all cases a substitute for leather or rubber, in mechanical uses, they are in many positions far superior to either of these articles; and as experience determines the places to which they are specially adapted, they supersede all competing goods for such uses. An immense trade is already done with axle-makers, carriage factories, and livery stables, for carriage-axle washers; with railroads and car manufacturers, for car-box washers and oil-box covers; with plumbers and faucet-makers for water packings of various kinds; and also with water companies, pump-makers, etc., for fire hydrants, pumps, etc."

THE MOSAIC INLAID TABLES.

In the Art Annex, ranged around the walls of the hall nearest to the main entrance, are a series of tables and table-tops, together with several pictures of great beauty, and exhibiting wonderful mechanical skill as well as artistic taste. The first is a table-top, 4 ft. long and 2 ft. 6 in. wide, of black marble, inlaid with other marbles, representing a sheet of music, the notes upon which are taken from the opera Norma. A tambourine, a sand-glass, a globe and frame, a mask, a pair of compasses, a guitar, and several sprays of roses and of grape-vine, are all faithfully represented, in form, color, and shading, by pieces of inlaid marble, the effect being truly marvellous. The price of this piece of art is $10,000. Next is a round marble table-top, about 2 ft. in diameter, with a black ground, having inlaid in its centre a spray of grape-vine with a pendant bunch of grapes, the colors of the numerous pieces of marble chosen so that the veins and all the various colors and shades of the leaves are represented true to nature. The pieces of white marble representing the grapes are semi-transparent, and being least opaque near the edges, give to each individual group the shading necessary to represent the rounded form of nature. There is no mechanical appearance either in the design or in the effect, which is as true to nature as can well be imagined or desired. These two are exhibited by the artist Giovanni Scappini, of Florence, Italy. Signor Civita, of Florence, Italy, exhibits a round table-top, with its centre inlaid with marbles, representing a spray of intertwined yellow and red roses, a tulip, convolvulus, lily of the valley, and dahlia, and ranged around the outside are six sprays of yellow and red roses. Every leaf, stem, and flower is represented in its minutest detail, and with a freedom that is very pleasing to the eye. The rounded stems and blooms appear to stand out from the surface of the table. Other specimens have birds of beautiful plumage and in various attitudes, the feathers being represented in both form and color by innumerable pieces of marble and other stone. All of the specimens mentioned, and about thirty others, are for sale, and a fair proportion have already been sold, several of them to residents of Philadelphia.

GERMANY AT THE CENTENNIAL.

There are two facts which usually rise uppermost in the mind of the visitor to the Centennial Exposition, when, after finishing the labor of sight-seeing, he begins to digest the results of his investigation. And these are, first, that the Japanese exhibit is surprisingly good, and second, that as compared with what might reasonably be expected, the German display is astonishingly poor. The average mind is more likely to dwell on the latter circumstance, because the disappointment is even greater than the gratification experienced in the former case. In all published accounts of the Exposition, however, a marked desire has been shown to deal lightly with the effects of the German exhibit, partly perhaps to avoid displeasing our estimable Teutonic fellow citizens, and partly for the patriotic motive of saying little regarding the shortcomings of our own Exposition. Be this as it may, nothing has been gained by slighting the truth, and many will be abruptly reminded of the fact by the bold and scathing letter which the chief German Commissioner, Professor Reuleaux, has lately published, and in which he mercilessly criticises his countrymen for the defects in and poverty of their representation.

It appears that among the Germans much less interest in the Centennial was taken than was popularly supposed in this country—a circumstance clearly shown by the absence of exhibits from the great majority of the large industrial establishments, while those who did contribute in the beginning did so more as a business venture than otherwise. Hence the prevalence of productions which we are already familiar with, on account of their already constituting the staple of a large commerce between Germany and the United States. After the Exposition had opened the Berlin Government appointed a scientific commission to take charge of the display. Of this body Professor Reuleaux was chief. He at once recognized that cheap fabrics, poor chromos, imitation jewelry, and the unending reproduction of likenesses of the Emperor, the Crown Prince, and Bismarck, in every variety of substance from soap to silver, were no fair representation of German art and German industry; and in the letter above referred to, addressed to a German journal, he says so with a vigor that leaves no doubt as to his sincerity. This missive has been copied by French and English journals, and their disparaging remarks have only added fuel to the flame of indignation raging among the German importers on both sides of the Atlantic, and among the still larger Teutonic element which resents as personal affront sneers at Bismarck and Unser Fritz, even when in effigy. In the midst of this excitement M. Reuleaux has been recalled, and the German display has been returned to the care of the Resident Commission, which controlled it prior to the advent of the wide-awake and enterprising professor.

As a specimen of honest and fearless criticism the letter commands our admiration, and it will doubtless do a great deal of good in turning many Teutonic eyes inwards to the shortcomings of their owners. Still, everything German in the Exposition should not be condemned on the strength of its assertions. The educational and book exhibit is creditable, that of Dresden china is exceedingly interesting, and the iron display in Machinery Hall is very good. We could mention other features that of themselves are admirable, and combined would lift the exhibit as a whole far above mediocrity, were the display of England and other nations immediately adjoining the German sections less magnificent.

In not saying this, however, Professor Reuleaux is guilty of but a slight failure of justice which every thoughtful visitor will redress. The main blemish of his letter is, that it entirely fails to notice a most vital subject relative to the industries and future progress of the German people, which is intimately connected with International Expositions, and that he lets pass an opportunity which might have been most prolific in good to both German and American inventors.

The most prominent exhibit in any part of the general German contribution is that of Krupp, the celebrated founder, of Essen, Prussia. We do not doubt but that Professor Reuleaux, in common with most of his countrymen, viewed the two enormous Krupp steel guns, and the fine show of metal which surrounds them in Machinery Hall, with some complacency, and to himself at least admitted that if there were any feature which redeemed the paucity of the German exhibit this was it. And yet, on the contrary, he might have taken those two guns as a text for launching the invective of which he is so able a master at the unjust system of German patent laws, through which a display far less creditable to Germany than brass jewelry or soap Bismarcks is permitted to be made in this country. We have on previous occasions made mention of the Broadwell gas check, which substantially is a combination of a self-adjusting spherical gas ring with an adjustable circular bearing plate, the two forming a perfectly gas-tight joint in the breech of a cannon, capable of easy repair, and now practically indispensable to breech-loading guns. In 1861, Mr. L. A. Broadwell, an American inventor and engineer, brought this device to the notice of the Prussian War Minister, and sought trials of the same with a view to its adoption by the Prussian Government. His request was refused, but immediately after Prussian guns fitted with his invention appeared, were used through the Danish war, and the device was ultimately adopted by Prussia, in utter disregard of the inventor's claims. Four years later, Broadwell having made a material improvement, again sought trials at the Prussian Minister's hands, was again denied, and once more his idea was not merely "adopted" and any compensation refused to him, but that he had a valid right was admitted in official reports, where the invention was constantly termed the "Broadwell" ring. As probably the largest gun-maker in the country, Krupp of course found the widest use for Broadwell's invention, and unlike some other German manufacturers, notably the Bergers of Wettin, who recognized Broadwell's claim, he followed the Government example in repudiating Broadwell, but clinging fast to his device. Since that time Krupp has inserted the ring in perhaps thousands of guns, it exists in the two exhibited at the Centennial, but when he personally is brought to task for the conversion, he points to a few minor improvements, and on the strength of them claims the whole invention as his original conception. Other American inventors, notably Mr. B. B. Hotchkiss, of rifled projectile and cannon fame, have had their inventions "adopted" in similar manner, until now it is generally well known, and we do not hesitate to advise inventors that to apply for a German patent on a valuable device is to invite its wholesale appropriation by the German people.

In view of these facts we naturally regard Professor Reuleaux's letter with some disappointment, for we can not but believe that so astute and able an observer must be thoroughly aware of the abuses under which foreign inventors in Germany suffer. Had he seized the opportunity to point these out to the notice of the world he would have added another act of justice and fearless good sense to the one for which he already deserves credit, and besides would have rendered his countrymen an even more valuable service.

CORUNDUM.

Mr. C. W. Jenks, of Boston, made some interesting remarks on corundum at one of the evening conversazione of the American Institute of Mining Engineers, Philadelphia. He said that the mineral corundum or pure crystallized alumina had been known and used by the natives of the East for many ages, who ranked its abrasive powers as next to those of the diamond. The chief sources of supply were certain districts in the Himalaya Mountains in Hindostan. As far as is known, the corundum was never legitimately mined in those districts, but it was picked up in the river valleys, where it had been washed by the annual rains. The amount of corundum obtained in this way was very small, not amounting probably to more than twenty tons per annum from all Asia. The name corundum now given to this mineral, whatever be the locality where it is found, was taken from the Hindoo word kurand, or cinnamon stone, the Hindoo variety having the color of that well-known product of the Orient.

The nine most valuable gems known as the Oriental—ruby, sapphire, emerald, etc.—are colored corundum. They have hitherto been found in the beds of rivers, and in the alluvial drift deposits in Burmah, Ceylon, Bactria, and India, occurring as more or less water-worn crystals. Emery, which is an impure corundum consisting of a mixture of alumina and magnetic oxide of iron, is found in many places in varying quantities, and is mined to some extent near Ephesus in Asia Minor, at Naxos in Greece, and at Chester in Massachusetts. Within a few years discoveries have been made of veins carrying pure corundum, in the western slopes of the Blue Ridge Mountains, in North Carolina. The granitic rocks which make up the principal mass of these mountains have been fissured in many places by large dykes of chrysolite and serpentine, in the localities where the corundum-carrying veins are found. These veins traverse the dykes, and are mainly composed of chlorite and chloritic minerals, carrying with them masses of corundum.

Mr. Jenks then showed a considerable number of specimens of corundum which he had obtained from some of these veins at an elevation of about 3000 feet above the sea.

The serpentine dyke which contains the veins from which the specimens shown were taken is about a mile long and from one to four hundred feet high. Five nearly parallel veins, which dip into the mountain side, have been already partially worked, and over 100 tons of corundum in all forms have been brought to the surface. The greatest depth yet reached in any of these veins is seventy-five feet. The corundum, which varies in size from microscopic crystals to lamellar crystalline masses, weighing as much as 300 pounds, is found embedded in many aluminous minerals, some of the most common of which are albite, orthoclase, ripidolite, and Jeffersonite. This matrix makes the extraction of the corundum from the vein quite easy, blasting seldom being necessary. The specimens of corundum shown by Mr. Jenks were very varied in character; some of them had the distinctive colors which belong to the ruby, the sapphire, the emerald, and the topaz. Several specimens, in fact, showed these different colorings in concentric layers in the same specimens.

Among several crystals of different color which were shown there was one quite handsome sapphire, which had been found in a matrix of granular corundum. Mr. Jenks stated that these crystals were sometimes found embedded in this way in corundum, and sometimes as water-worn pebbles embedded in the ripidolite. Mr. Jenks expressed the opinion that had the masses of corundum containing these crystals been exposed to water action, their lamellar structure would soon cause them to disintegrate and leave the gems as they are generally found. This fact of the discovery of these crystals associated with the massive corundum, he thought, seemed to dispose of the theory heretofore held by many mineralogists, that their formation has taken place in the secondary formations. As is well known, the abrasive powers of pure corundum are greater than those of emery. Experiments which have been made with this corundum at the Springfield Armory and elsewhere, have shown it to accomplish thirty-five per cent more work than the best Naxos emery. When cemented in vitrified wheels, it cuts readily and rapidly granite, chilled iron, hardened steel, all the corundum gems, and even the diamond. From what has already been done, it is known that this corundum can be put in the market, cleaned and graded for use, at a cost of twenty cents per pound. The specimens shown by Mr. Jenks can now be seen in the North Carolina collection of minerals, which are included in the Smithsonian collection in the Government Building.—*Engineering and Mining Journal.*

THE MANCHESTER STEAM USERS' ASSOCIATION.

At the request of the Judges, Group 20 of the American Exhibition, the Manchester Association sends the following particulars of the operation of their society :—

Offices : 9 MOUNT STREET, MANCHESTER, July 4, 1876.

THE CENTENNIAL COMMISSION, INTERNATIONAL EXHIBITION, PHILADELPHIA.

For the Use of the Judges in Group 20.

GENTLEMEN :—In reply to a letter received from Mr. Chas. T. Porter, requesting information as to the working of the Manchester Steam Users' Association, for the use of the Judges of the International Exhibition, Philadelphia, I beg to forward the following particulars, and in doing so will take up the points seriatim, in the order in which they occur in Mr. Porter's letter.

No. 1. *" Term of Existence."*—The Association was established in the year 1854, and has been in active work ever since, increasing in the number of its boilers and the area of its operations.

No. 2. *"Average and Present Number of Boilers in charge."*—The number of boilers now under inspection is as nearly as may be 3000. The average for the last five years has been 2900.

No. 3. *Character of the Boilers, and if of different types the number of each.*—By far the greater number of boilers enrolled with the Association are horizontal, and internally fired. Speaking approximately, the relative number of the various types is as follows :—

50 per cent are what are termed "Lancashire" boilers ; that is to say, having two internal tubes running through them from end to end, in which the fires are placed.

15 per cent are of the "Cornish" Type ; that is to say, having one furnace tube running through it from end to end, in which the fire is placed.

15 per cent are externally fired, such as plain cylindrical, egg-ended colliery boilers ; French or "Elephant," and "Butterly" boilers.

8 per cent are variations of the "Lancashire" and "Cornish" boiler, with a number of small flue tubes, some termed multiflued, and others multitubular, etc.

6 per cent are of the "Galloway" type.

6 per cent are of miscellaneous types, such as boilers at iron-works heated by flames passing off from puddling and iron furnaces, water-pipe boilers, locomotive and marine boilers, and vertically internally fired boilers, etc. This proportion varies somewhat year by year, as boilers are changed.

No. 4. *Pressure carried—between what limits.*—All the "Lancashire" boilers made for members under the inspection of the Association, the ruling diameter of which is 7 feet in the shell, and 2 feet 9 inches in the furnace tubes, are fit for a working pressure, as a minimum, of 75 pounds on the square inch. Many are fit for a pressure of 85 pounds, others 90 pounds and 100 pounds. No new boilers are made to the Association's standard for a lower pressure than 75 pounds on the square inch. Many smaller boilers are carrying 120 pounds.

No. 5. *Character of the Examinations made, and their frequency.*—A complete examination of every boiler is made both inside and outside, when at rest and properly prepared, at least once a year, and more often if necessary ; that is to say, if the boiler does not appear thoroughly sound or repairs have to be examined. Hydraulic tests are also had recourse to when necessary. In addition to the annual thorough examination, two "External" examinations are made of each boiler per annum, with the boilers at work and steam up. This number is a minimum.

No. 6. *Nature of the Defects and the Number of each per annum.*—The following is a list of the defects discovered, with the number of each for the year 1875.

Furnaces out of shape	22 ;	3	dangerous.
Fractures	87 ;	10	"
Blistered plates	79 ;	6	"
Internal corrosion	163 ;	5	"
External corrosion	104 ;	21	"
Internal grooving	117 ;	1	"
External grooving	9 ;	2	"
Feed apparatus out of order	1		
Water-gauges "	7		
Blow-out apparatus "	14 ;	3	"
Fusible plugs "	6		
Safety valves "	30 ;	8	"
Pressure gauges "	110 ;	7	"
Boilers without glass water-gauges	2		
" " safety valves	8 ;	1	"
" " pressure guages?	6 ;	4	"
" " blow-out apparatus	6		
" " feed back-pressure valves	51		
Cases of over pressure	9 ;	5	"
Cases of deficiency of water	2 ;	1	"

Total—defects, 833 ; 77 dangerous.

No. 7. *" Instructions given to Owners and Firemen."*—We have no written code, but are thinking of preparing a list of instructions to firemen. All we ask from the owners is, to get a good boiler and a careful man. We impose no arbitrary conditions. Information to the owners is always accessible at these offices.

No. 8. *The Guarantee afforded to Members.*—The Association guarantees the members freedom from explosion, and the Association's guarantee has never failed. Its members continue to enjoy immunity from explosion year after year. As a pledge of good faith, the reports are endorsed with a pecuniary guarantee of £300, but the Association has no explosions. The only exception to this was the rending of a furnace through overheating in consequence of misuse by the owner, who charged the boiler heavily with caustic soda and arsenic, bringing down the incrustation but yet neglecting to blow out. No one was hurt, and the boiler was soon repaired and set to work again. We warn our members against using compositions and neglecting to blow out. We guarantee our members perfect immunity from explosion, provided only they meet us with ordinary fairness. Year after year we are able to report *"No explosion from any boiler guaranteed by the Association."*

No. 9. *The Cost to Members of the Inspection and Guarantee.*—The charge for inspection is one guinea and a half per annum each boiler, within a radius of 40 miles of Manchester ; beyond that distance according to arrangement. There is no charge for guarantee. The Association's guarantee is neither to be bought nor sold. If the Association considers a boiler unsafe, nothing will induce it to say it is safe. If the boiler is safe, there is no need to charge for saying so. The expenditure is incurred in inspection, and the Association has no explosions to make compensation for.

No. 10. *" The Result of the Work of the Association in Immunity from Accidents."*—It is presumed that by the word "Accidents" is meant explosions. Explosions in the great majority of cases are *not* accidental. They arise from known causes. Inspection is able to prevent their occurrence, and is found in the experience of the Association to be quite adequate. *See here reply to question No.* 8.

No. 11. *Upon what do you rely for Safety ?*—Upon competent periodical inspection. *See reply to questions* 8 *and* 10.

No. 12. *" Low-water Detectors."*—We recommend that each boiler should have two good glass water-guages, fixed directly to the front end plate of the boiler, immediately under the eye of the attendant. We approve of a low-water safety valve which relieves the pressure of the steam as soon as the water falls below the desired level. Alarm whistles may be easily silenced, and, as a rule have been discarded. A low-water safety valve is more reliable, as it blows off either for high steam or low water, and thus is kept in constant play.

No. 13. *"Automatic Feed Regulators."*—We do not approve of these, thinking them apt to mislead, and to engender a false confidence. We prefer feeding by hand as more trustworthy.

No. 14. *" Testing Boilers in use by Hydrostatic Pressure."*—We do not adopt this course as a rule, and only adopt it where there is some peculiarity in form, say to ascertain the strength of a flat surface, or when any question arises as to the power of a furnace to resist collapse. In the case of the cylindrical shells of boilers, we rely on careful inspection. If the plates appear to be wasted we drill them to ascertain the precise thickness, and sound the rivet heads to see if corrosion is interfering with the consistency of the metal. We have the boiler so set that all parts may be accessible to examination. If the brickwork interferes we have it removed. When hydraulic tests are applied, the boilers are gauged at the flat ends, and also in the furnace tubes, to see if any movement occurs. We have no faith in "blind" hydraulic tests for getting at the strength of parts out of sight. Our rule is to see every thing.

No. 15. *" The Experience and approved Usages of other Similar Associations in England."*—The object of the Manchester Steam Users' Association is the saving of human life and the prevention of explosions. It has no shareholders and pays no dividends. The president and members of the executive committee give their time gratuituously year after year in the interest of the members and the public generally, with the object, as already stated, of saving life. There is no other similar association in the country, but there are joint-stock boiler insurance companies, founded for the purpose of dividend. I think I have now replied to all the inquiries contained in Mr. Porter's letter, but may add that our Association goes to the expense of sending a qualified officer to investigate every explosion that occurs in any part of the country, and draw up a full report, with illustrative drawings of the same. These are carefully preserved at the offices, and form most instructive and valuable documents. A very abridged statement of the description of boiler, course of the rents, effects of the explosion, and the cause, is given in a tabular synopsis published in the Association's printed monthly reports, circulated amongst the members, and sent to the press gratuitously, so as to disseminate the information as widely as possible.

The Association has boilers enrolled under its inspection situated in all parts of the United Kingdom. Also it has several corresponding members abroad, and is affiliated with another institution for the periodical inspection of boilers at Calcutta. Its monthly reports will be found in the library of the Franklin Institute at Philadelphia.

Trusting that this information will be of service to you, and wishing you every success in your labors,

I remain, Gentlemen, yours faithfully,

L. F. FLETCHER, *Chief Engineer.*

CONGRESS OF BELGIAN SCIENTIFIC BODIES.

THE first Congress of the Confederation of the Scientific Bodies of Belgium was opened on the 16th July, in the Academical Hall of the University of Brussels. Of the eleven societies in federation, eight were officially represented—namely, the Malacological Society, the Belgian Microscopical Society, the Geological Society of Belgium, the Medico-Chirurgical Society of Liège, the Liège Veterinary Society, the Instruction League, the Liège Council of Public Health, and the Hasselt Philharmonic Society ; but there were present members of the three remaining bodies—namely, the Federation of the Horticultural Society of Belgium, the Hainault Scientific Society, and the Namur Archæological Society.

Dr. Crocq traced the history of the Confederation, refuted several erroneous opinions concerning it, and expressed the hope that it would soon embrace all the learned societies of Belgium.

After each society had handed in a report of its labors, the three sections of physics and natural science, medicine and pharmacy, and history and literature, were formed for deliberation during the session.

After debating the first question—namely, the obtaining of greater facilities for the transmission of scientific objects—it was resolved to demand from the Government : (1) transmission of scientific specimens under certain rules ; (2) the removal of absolute prohibition to the transport by post of glass and liquids ; (3) free carriage of the publications of the scientific societies (as has been accorded to the Syndical Union and the Committee of the Hygienic and Life-saving Exhibition) ; and (4) a reduction of 50 per cent on railway fares for members of the Confederation attending meetings of the allied societies.

The second question, as to the opening of public scientific institutions at hours more convenient to the scientific public, and specially that the libraries and museums of the State should be placed at the disposal of students in the evening and during Sundays, was, after discussion, adopted as far as the libraries are concerned, but modified with respect to the museums.

On the following morning, the consideration of the third question, as to the interchange of reports of the proceedings of the federated societies, was deferred. In connection with the fourth subject—namely, the organization of libraries and scientific collections in the towns and communes, M. Ch. Buls read a paper, in which he pointed out that, as popular libraries existed in almost all the towns, it would be sufficient to add to them such scientific works as were recommended by the federation ; the exact list might be supplied by the Instruction League. As no scientific collections existed in the country it would be useful to establish them ; and the initiative should be taken by local societies. These small scientific museums would chiefly comprise geography, geology, and the *flora* and *fauna* of the surrounding country, having also divisions of history, archæology, manufactures, and agriculture.

The following resolutions were then adopted : (1) Statistics as to the Belgium libraries shall be compiled ; (2) a catalogue shall be prepared of the scientific works recommended for these libraries ; (3) a circular setting forth the utility of the local museums shall be addressed to the scientific bodies of Belgium ; and (4) the communal authorities shall be memorialized to encourage the establishment of these museums by a suitable local *octroi* duty.

The fifth question, as to the publication of small elementary treatises on different branches of science, was also brought forward by M. Ch. Buls, who stated that a certain English learned society published, under the title of science primers, elegantly bound volumes, containing a hundred pages, for a shilling. It would be sufficient to translate the greater part of these treatises, written by the most eminent of English scientific men, and free from those abstractions which render the study of science so dry to the general reader. The description of the local museums, dealt with by the fourth question, would also be an excellent theme for these small works. It was in this spirit that Dr. Meynne, of Bruges, had just published the first volume of a series of treatises which he intends to devote to the history and description of the Belgian maritime zone, and entitles "Lectures de la Plage." M. Buls' report was adopted, without, however, any decision having been arrived at as to the means by which it was to be carried out.

In the afternoon the whole Congress considered the question proposed by the Malacological Society : Would it be useful to possess in Belgium, in one of the littoral towns, an institution appropriated to all studies connected with the coast, and what would be the best means for carrying this out ? M. Lefèvre, in support, lamented the backwardness of Belgium in this respect. France possessed several of these institutions, the chief of which are at Roscoff, Vimereux, Concarneau, Arcachon, and Marseilles. The Roscoff Institution of Maritime Zoology, founded five years ago by M. Lacaze Duthiers, was especially adapted to the study of marine *fauna* and *flora*. It is arranged so as to receive four naturalists, and places at their disposal all the appliances necessary to their labors, as well as a library consisting principally of works on the *fauna* of the French coasts. There is also an aquarium where they may study living examples of the species collected in their excursions. Two shore-boats, manned by the State, are constantly at the disposal of the naturalists. M. Lacaze Duthiers publishes in "Les Archives de Zoologie Expérimentale" papers containing the results of his observations.

The establishment at Vimereux is due to one of the members of the Malacological Society. It has only cost 3000 francs (£120) during the first year, and has already aided in important works, several of which have been published in the bulletin of the Académie. At Concarneau experiments in pisciculture have been carried out by Coste de Gerbe and Pouchet, while Marseilles has facilitated the researches of Lespès and Marion.

After referring to the aquariums in England, and the zoological collections of the British Museum, the Royal College of Surgeons, and the Zoological Gardens, M. Lefèvre observed that Naples possessed the finest zoological institution in the world, founded but a few years ago by Dr. Dorn, at a cost of 400,000 francs (£16,000), and subsidized by England, Prussia, Russia, and other countries, the German government having just granted a sum of 30,000 francs (£1200) for a steamer, to be used in dredging the bottom and excursions in the Bay of Naples. All European countries were, in fact, represented at the international station of Naples, except Belgium ; even Holland was about to inaugurate an institution for zoological survey like that of Naples, and it was impossible for Belgium to remain in the background in this respect. The Congress, supporting M. Lefèvre's paper in its entirety, decided that the Federation should take the necessary steps to obtain from the Government the foundation of a zoological institution in one of the maritime towns.

MM. Vincent, Ruthot, and Vanden Broeck then read papers on the geological formation of the neighborhood of Brussels ; and, on the 18th, these gentlemen conducted an excursion with the object of substantiating their views.

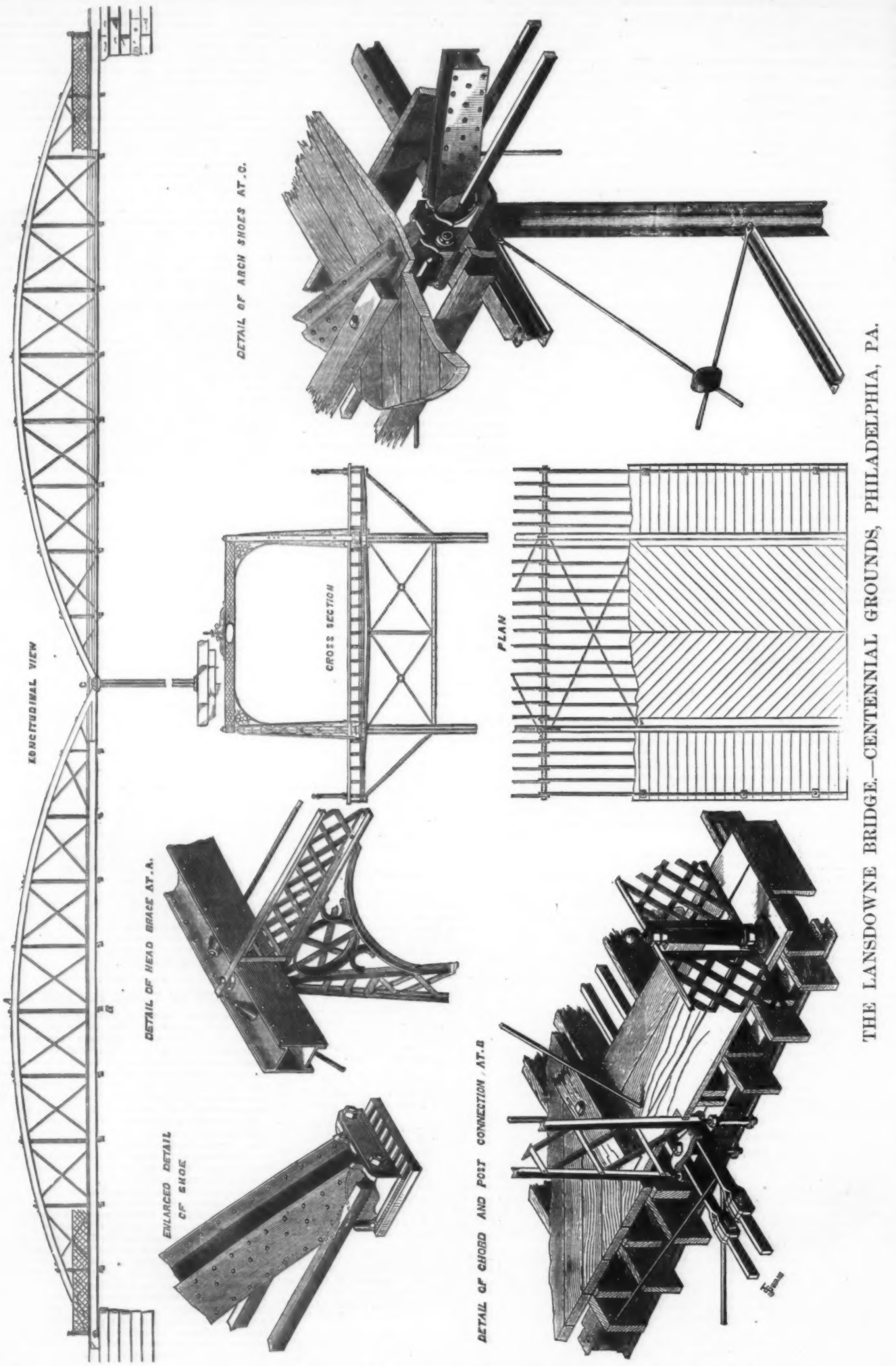
At the closing *séance* in the afternoon, the questions not disposed of were adjourned to the Congress of 1877, which is to be organized at Mons by the Hainault Scientific Society ; it was also decided that the Congress of 1878 shall be held at Liège, under the auspices of the Geological Society of Belgium. The Secretary read a *résumé* of the proceedings by Dr. Crocq, and the Congress was closed.

AWARD OF PRIZES FOR IMPROVEMENTS.

IN the recent annual distribution of prizes by the French *Société d'Encouragement* the Prony *grande médaille* was awarded to M. Giffard, the eminent Paris engineer. His injector, which excited such universal surprise when it was made known in 1861, has been found a most useful adjunct to steam boilers, especially to locomotives. The invention was highly original and novel. M. Giffard has also made some valuable improvements in aërostation. The captive balloon at the Paris Exhibition in 1867 was his. He has done much towards preparation of envelopes impermeable to hydrogen, and the regular and economical manufacture of this gas. A prize (of 4000 francs) for improvement in the cutting of mill-stones, with regard to the health of the workmen, was awarded to M. Roger, who has found a means of performing the work mechanically. The machine is placed in a closed space ; the continuous presence of workmen is dispensed with, and their health thus saved. Two other workmen, of Ferté-sous-Marne, received a prize for improvement in protection against dust by means of humid masks. A prize (of 2000 francs) was awarded to M. Thonion for the care and intelligent direction given by him to organizing and executing the irrigation of the plain of Conflans, near Albertville. Another (of 2000 francs) to M. Le Roux for important embankments made in the bays of Mont Saint-Michel and of Veys. Various sums were given in encouragement of efforts to produce a pulverulent manure of moderate price, to rear silkworms so as to maintain in a permanent way grains exempt from all disease, installation of movable pens for rearing rabbits in the open country, etc., etc. [For further particulars of the prize distribution we must refer to the society's *Bulletin* for July.]

COMPRESSED-AIR ENGINE.

WE are informed that the model of a compressed-air engine for mines, which was described in the SCIENTIFIC AMERICAN SUPPLEMENT, page 624, was invented and made by Mr. George G. Fryer, a young Philadelphian, now a student in the Polytechnic College of Philadelphia. The article gave the credit of the invention to the students at large, but while they have done much, the idea, we are told, originated with Mr. Fryer.


LONGITUDINAL VIEW
CROSS SECTION
PLAN
DETAIL OF ARCH SHOES AT C.
DETAIL OF HEAD BRACE AT A.
ENLARGED DETAIL OF SHOE
DETAIL OF CHORD AND POST CONNECTION AT B

THE LANSDOWNE BRIDGE.—CENTENNIAL GROUNDS, PHILADELPHIA, PA.

LANSDOWNE BRIDGE, CENTENNIAL GROUNDS.

We illustrate a bridge thrown over a valley in the grounds of the Philadelphia Exhibition, constructed under the patents of Mr. King, of Cleveland, Ohio. The extreme length is 208 ft., number of spans two; extreme length of each span, 104 ft.; width of roadway in clear, 18 ft.; there are two sidewalks each 6 ft. wide; the number of panels is ten; the height of arches at crown equal $\frac{1}{12}$th of the length of the span. The truss arches consist of two 7 in. channel iron, and two plates of boiler iron, each 9 in. by $\frac{7}{16}$ in. at centre or crown of arches, and 10 in. by $\frac{7}{16}$ in. at ends or feet of arches. The channel irons and plates are securely riveted together with $\frac{3}{4}$ in. rivets, placed 6 in. apart to centres, hot pressed and hot riveted. An interior channel iron extends 20 ft. up from foot of each arch. The extremities of the arches are formed into shoes of cast iron resting on the abutments or piers, with a flat bearing of 12 in. to 14 in. from heel to toe, and have a firm connection with ends of the chords by thread and nut connections of same sectional area as in the main chords. The ends of the arch joints are planed to form a bearing, and the joints lap 30 in. The chords are composed of flat bars, each 3 in. by $1\frac{1}{8}$ in., two under each arch. All chord connections have enlarged heads, containing the same sectional area as in the main chords. All cord pins are turned, and not more than $\frac{1}{64}$ in. less in diameter than the pin holes. There is a single set of posts under each arch, formed of $2\frac{1}{2}$ in. star iron in first two panels from ends of arch; post three, two $2\frac{1}{2}$ in. star iron and lattice bars, four; one 3 in. star iron; post five, two 3 in. star and lattice bars 2 in. by $\frac{1}{4}$ in., the upper ends of which pass through the centre of the arches, with thread and nut connections; the lower ends of the posts pass between the lower chords, and through connecting blocks of cast iron,

Screw nuts both over and under the chords hold the post securely in place, making the same adjustable, and obviating the necessity of cutting holes through the chords, and reducing sectional area of same.

The diagonals cross each other, two in each of the quadrilateral panels of the truss, consisting of 1¼ in. rods in the first panel from ends, and the remainder are ⅞ in., ¾ in., 1 in., and 1⅛ in. rods. The end of the diagonals pass obliquely through the arch and connecting blocks, with screw nuts at end for adjustment. The nuts on both posts and diagonals at upper ends are hexagonal, and properly proportioned for the purposes intended. To give lateral steadiness to the structure, there is a pair of diagonal sway rods, each 1 in. diameter, at the end panels of the bridge; the remainder of the panels are of ¾ in. rods. The system of sway bracing commences at the feet of the arches, passing diagonally from that point to first post from end of bridge; starting from that point, continue through entire length of structure. There are three side braces of 3 in. star iron and lattice bars.

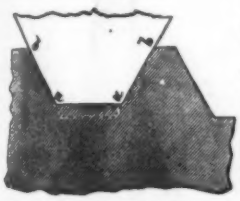
The bracing over the floor is high enough to leave a clear headway of 14 ft. and of one panel of lattice bracing. The lattice head brace is formed of four 2 in. L and lattice bars 2 in. by ¼ in., brace being 14 in. deep. The wrought-iron floor beams are 12 in. in depth, the coal plate 12 in. by ⅜ in., and four 2½ in. L irons; each beam extends outside of the chords to support the sidewalks. The floor joists are of pine timber 12 in. deep and 3 in. thick, placed 2 ft. apart from centre to centre. Floor plank is of pine 3 in. thick, and not more than 12 in. or less than 8 in. wide, spiked to the floor joists with 5 in. spikes.—*The Engineer.*

FRICTIONLESS TAPS AT THE EXHIBITION.

By Prof. J. E. SWEET.

IT is well known by mechanics that a tool to easily and properly cut metal, requires a clearance between the back of the tool and the surface acted upon. This principle is applied in the construction of nearly all tools, except in solid dies for threading bolts and gas pipe, and in the ordinary fluted taps for tapping holes.

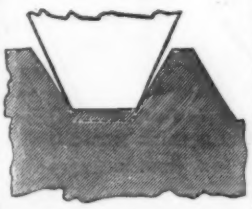
Fig. 1



In the common fluted taps where the thread is cut in the lathe, and the points of the thread are filed away to give a clearance or relief to their cutting edges, there is still the sides of the cutting edges without clearance, as shown at *a*, *b*, Fig. 1.

Various plans have been adopted to give relief to these sides. The most common one is that of filing in between the threads with a three-cornered file; another method is when the same result is produced by machinery, either in the lathe or milling machine, by causing the tool to advance or recede as the blank tap is being cut, producing not a perfect cylindrical section, but one approaching a triangle or square, as the finished tap is to be either a three or four fluted one. But in all these plans there remains this unnecessary friction, that is, the friction of the cutting edges, of all subsequent cutting teeth, rubbing along over the finished work of those cutters which have done their work before.

Fig. 2



In the construction of a specimen tap shown in Machinery Hall, Centennial Exhibition, at Cornell University stand, B-68, a different method has been adopted—one that not only gives a relief to the cutting edges of the tap, but eases the sides as shown in Fig. 2, and one that can be produced by the ordinary lathe. The work consists in cutting the thread and turning the taper in the usual way. Then, that the subsequent operation may be better observed, the blank is heated to change its color. The blank, before being fluted or grooved, is put in the lathe with the foot-stock of the lathe set back; that is, the reverse of position it occupied when turning the taper on the tap, and then with a tool somewhat more acute than the one used for cutting the thread, the bottom of the thread is turned away until a new angle is formed on the sides of all threads up to about one diameter of the tap, which is left in its original condition to clear out and leave a finished hole. When such a tap is fluted and the outer surface between the flutes filed away, all parts of the tap have a clearance, and so far as the cutting edges are concerned, a better clearance than if made by either of the old methods.

Fig. 3

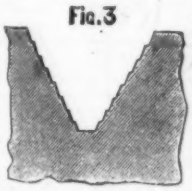
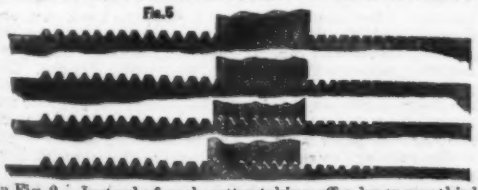


Fig. 4

Another invention applicable to this or any other style of tap is shown in Figs. 4 and 5. In the ordinary tap, with the taper four or five diameters in length, there are far more cutting edges than are necessary to do the work; and if the taper is made shorter, the difficulty of too little room for chips presents itself. The evil results arising from the extra cutting edges are that, if all cut, then it is cutting the metal uselessly fine—consuming power for nothing; or if some of the cutting edges fail to cut, they burnish down the metal, not only wasting power, but making it all the harder for the following cutters. One plan to avoid this is to file away a portion of the cutting edges; but the method adopted in the University tap is still better. Assume that it is desired to make three following cutters, to remove the stock down to the dotted line

Fig. 5



in Fig. 2. Instead of each cutter taking off a layer one third the thickness and the full width, the first cutter is cut away on each side to about one-third its full width, so that it cuts out the centre to its full depth, as shown in Fig. 4, the next cutter cutting out the metal at A, and the next at B. This is accomplished by filing, or in any other way cutting away, the sides of one row of the teeth, all the way up; next cutting away the upper sides of the next row and the lower side of the third, leaving the fourth row (if it be a four-fluted tap) as it is left by the lathe, to insure a uniform pitch and a smooth thread.—*Polytechnic Review.*

THE GREAT SUSPENSION BRIDGE BETWEEN NEW YORK AND BROOKLYN.

PROGRESS OF THE GREAT SUSPENSION BRIDGE BETWEEN NEW YORK AND BROOKLYN.

ON the afternoon of Friday, August 26, Mr. E. F. Farrington, Superintendent of Construction of the East River Bridge, made the passage from tower to tower in a "boatswain's chair" suspended from the wires put in position a week previous. The chair was simply a piece of board about two feet long by one wide, with two holes in each end through which ropes are passed. The ropes were about four feet long, fastened to the cable at one point. Mr. Farrington started from the Brooklyn anchorage. He sat in the chair clinging to the ropes which supported it. As soon as he had taken his position in the chair, the engine at the Brooklyn anchorage was started, and the immense endless cable—6800 feet in length—began to revolve around the drums. Slowly he passed up from the anchorage to the tower. As he approached the massive pier, Mr. Martin, who was superintending the engine, gave orders to slow up, and when the signalman reported the chair within ten feet of the tower the engine was stopped. This was considered the most perilous point in the journey, because if the engine was not stopped in season the chair would be drawn on the pulley and the occupant thrown out. Mr. Farrington was then hauled upon the tower, where a large party of ladies and gentlemen had assembled.

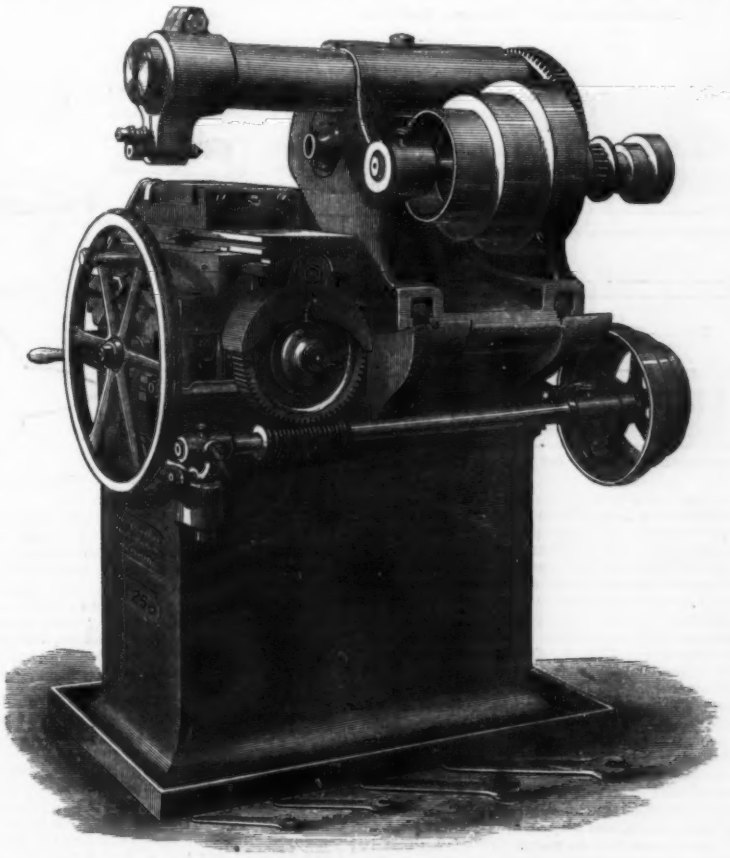
The chair was then attached to the cable on the river side of the tower, and the Superintendent taking his position gave a signal, and the cable again began to revolve.

All the ferry-boats, tug-boats, and steamers in the river set up a screeching. Every pilot seemed simultaneously to have seen Mr. Farrington on the wire. Some of the ferry-boats were stopped in the middle of the river, and the ladies on the boats, on the piers, and on the housetops wildly shook their handkerchiefs. Men and boys shouted and swung their hats, and Mr. Farrington, seemingly enjoying his ride, held his handkerchief in the breeze. When near the centre of the crossing he clapped his hands, and seemed immensely pleased. While nearing New York pier the wire was bent so that the trip was almost perpendicular, and Mr. Farrington stood in his seat and was thus safely carried to the top, and the first man who crossed the great bridge was greeted with terrific cheers. The trip from pier to pier was made in six minutes and forty-five seconds. The ride from the New York pier to the anchorage was accomplished in four minutes.

Mr. Farrington took this trip for three reasons, namely—to inspire confidence in the men who are to follow him; to make personal observations, and for the satisfaction of enjoying the triumph of his undertaking.—*Frank Leslie's Illustrated Newspaper.*

BEMENT'S MILLING MACHINE.

WE illustrate one of the forms of milling machine constructed by Messrs. Bement & Son, of Philadelphia. This machine is adapted especially for gunwork, and no less than 150 of the same pattern were supplied not long since to one firm employed in filling a large European order for small arms. One special feature of the machine consists in the fact that that portion of the frame carrying the driving pulleys, mandrel, and headstock arm turn around a centre, corresponding with that of the driving pulley shaft, so that the mandrel and milling tool can be set to any desired angle without affecting the length of the driving belt. As will be seen from the drawing, the machine is provided with three-speeded pulleys, and can be fed either by hand or by power. If the former, the worm shown is thrown out of gear and the hand wheel employed. The table to which the work is secured has a universal movement 12 in. in one direction and 4½ in. in the other.—*Engineering.*



MILLING MACHINE FOR GUN WORK.

JAPANESE LACKER — ITS MANUFACTURE AND APPLICATION.

IN one of the cases in the Japanese section of the Main Building at the Centennial Exposition there is a division devoted apparently to neatly made prisms of wood. In some prisms the wood is in its natural state, others seem to be merely painted black, others prisms again are varnished and polished, and finally others are shown covered with gold and silver powder, and with designs both flat and in relief. The eye thus successively ranges from the simple piece of cedar, and notes every change which finally renders the valueless block an exquisite object of art. Through the courtesy of the Japanese Commissioners we (*La Nature*) have been enabled not only to examine these very interesting specimens at our leisure, but in response to our inquiries relative to the fabrication of the lacker, authentic documents, which have not yet been translated into English, have been placed at our disposal. As a guide to the description of the various processes, a treatise written in Japanese and dated about 1570, by one Igarashi, was recommended by the Commissioners, and from this unique work the annexed engravings have been copied.

Objects in lackered wood ornamented with paintings are termed in Japanese *Makiyé*, a word which signifies powdered or lackered painting. The material best adapted for the work is *kinoki*, the wood of a species of pine botanically termed *Retinispora obtusa*. The piece having received the desired form is plunged for an instant in boiling water, then wiped, and dried in the shade. It is next covered with lacker—the word is here employed in the sense of varnish—

SKETCHING THE DESIGN.

Now, on very thin, closely made paper, the design, Fig. 3 for example, which is to appear on the object, is sketched. To transfer the marks to the work, a peculiar varnish called *yaki-urushi*, or burned lac, is employed, made as follows: A band of paper is rolled in tube form (Fig. 4), an end being left unwound. A very small quantity of the *seshime-urushi* is placed on this end and heated quickly to effervescence. Adding a very little red oxide of iron and camphor, the whole is carefully mixed and filtered. The varnish thus prepared warm does not become dry and friable. The paper painted side up is now attached to the object and rubbed with a whalebone spatula (Fig. 5). This causes the lines to be transferred to the prepared surface. A bit of tow is then used to dust on tin in powder, and the excess of the latter is removed by a very soft pencil (Fig. 6).

PAINTING THE DESIGN

is done with a lac called *shitamichi urushi*. This is a mixture of *seshime-urushi* one sixteenth part, *nashyi urushi* four tenths, a small quantity of red oxide of iron of intensely red color and a little camphor. This is mixed and filtered four times, the more frequent the filtering the purer the material. The latter is then placed in a shallow cup (Fig. 7), and covered with a piece of permeable paper, which comes in contact with its surface and prevents its hardening from contact with the air.

The varnish thus prepared is laid on by means of a very fine pencil (Fig. 8), which is composed of rat hair. The little finger is placed on the side of the object, so that the

day and a half's rest is allowed, at the end of which time the rat-tail brush is used to apply to the more delicate shades *yosheno-urushi* varnish, camphorated and filtered. Polishing with *camelia japonica* charcoal follows; and this is a most delicate operation, requiring the longest practice, for here is constant danger of rubbing off the thin layer of metal. A little schist powder is scraped from a tender piece of the stone, mixed with oil, and applied to the painting with the finger-tip, to produce a polish. The operation of gilding, etc., is then repeated, and then with a wad of tow the appropriate metallic colors for the objects depicted are applied. Next comes covering with *yosheno-urushi* varnish, wiping with cotton and paper, polishing with *shikido* (another schist) and oil, another application of camphorated varnish, then of the same mingled with water, another drying, and then a final polishing with powdered horn. The object is now uniformly brilliant, and the gold portions are finished. We may here leave it in order to explain

HOW THE METALS ARE PREPARED.

To prepare the *kirikane*, or cut metal, a leaf of the same is spread upon a cylinder of bamboo (Fig. 13), and covered with paper. Then, by means of a razor, a number of fine equal bands are cut, a margin on each side being left intact. The leaf and paper are then turned so that the strips occupy a position perpendicular to that which they had at first. Carrying the razor in the former direction around the bamboo, the squares of metal leaf are detached and fall into a blackened saucer (Fig. 14). To pick up the pieces, a small stick of willow (Fig. 15) is used, slightly moistened with saliva. Gold, copper, and silver are treated in this way.

FIGS. 1 AND 2.—VARNISH SPATULA AND SOOT-VARNISH BRUSH.

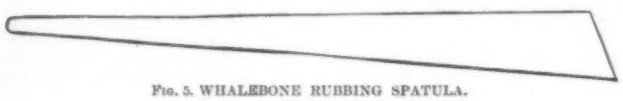


FIG. 5. WHALEBONE RUBBING SPATULA.

FIG. 8.—RAT-HAIR PENCIL.

FIG. 10.—BRUSH FOR PRIMING POWDER.

FIG. 18.—MODE OF INDICATING WATER.

FIG. 4.—MAKING THE TRANSFER VARNISH.

FIG. 11.—RUBBING PIECES OF SCHIST.

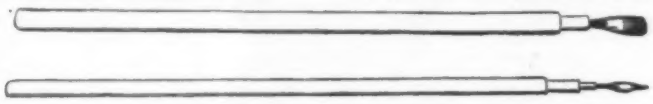


FIG. 12.—RAT-TAIL PENCILS FOR PAINTING THE DESIGN.

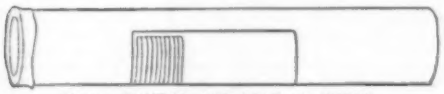


FIG. 13.—BAMBOO AND LEAF OF METAL.

FIG. 14.—BLACK SAUCER FOR METAL FLAKES.

FIG. 3.—PART OF SKETCH OF DESIGN.

Fig. 15.

Fig. 16.

Fig. 17.

FIG. 15.—WILLOW SPLINTS FOR HOLDING METAL FLAKES.
FIG. 16.—BUFFALO-HORN CUP FOR VARNISH.
FIG. 17.—GOOSE-FEATHER SIEVE.

FIG. 6.—DUSTING BRUSH

FIG. 7.—VARNISH CUP.

FIG. 19.—MODE OF HOLDING THE GOOSE-FEATHER SIEVE.

FIG. 9.—METHOD OF HOLDING THE RAT-HAIR PENCIL.

and over this coating is sifted a layer of *jisun*, or unglazed pottery finely pulverized. Another powder is made of a schistous stone (*tonoko*), which is mixed with *jisun* to form *kiriko*. This is diluted with lac varnish by means of a wooden spatula termed *urushi hera* (Fig. 1). When the mass is perfectly homogeneous, the spatula is employed to lay it on as a groundwork on the object, which is then enclosed in a case, probably to protect it from dust, etc., and left quiet for a day and a half in summer and somewhat longer in winter. Then with a piece of the schist the entire surface is rubbed smooth.

A new paste of powdered schist and *seshime* (a kind of lac) without *jisun* is now prepared and applied, dried and polished as before. Then the whole is rubbed with a wad of cotton soaked with lac, and carefully wiped with very fine paper, softened by long crushing in the hands. The object is next again enclosed and left to rest for half a day. Still another preparation is then made, composed of a different kind of lac—*nuritate-urushi* and *shoyen*, or soot produced by the burning of pine knots rich in resin. This is intimately mixed and filtered through paper. In the mixture a flat brush, such as is shown in Fig. 2, is dipped, and with this implement the object is covered with a smooth coating. Another drying of two days' duration, succeeded by polishing with *Honoki* charcoal, follows.

These preliminary operations constitute the *shita nuri* or sub-lackering. The intermediate stage (*naka nuri*) consists simply in repeating the preceding painting with the soot mixture. Then begins the *ura uri*, or surface lackering.

The object is first covered with *kcero-urushi*, a very fine and brilliant varnish, greenish black in hue and purified by filtration. When dry, polishing by charcoal follows, and rubbing with schist is continued until not the least inequality on the surface is perceptible. At this point the schist powder is diluted with oil, and this is used as a polish until the surface becomes brilliant.

brush is held vertically and only the tip used (Fig. 9). When this work is terminated, the design is covered with a priming powder by means of the brush, shown in Fig. 10, and the object is returned to its case to rest. This last powder consists of Honoki charcoal, mixed with three-tenths sulphur. The whole is pulverized in a mortar and sifted through silk. On the next day rubbing with *seshime-urushi* mixed with camphor, and another polishing with schist, follows.

THE RUST FINISH.

This name is given to the operation which produces the relief work for the figures. A mixture of *seshime* and schist powder is made pasty and applied with a spatula. The portions not desired to stand in relief are removed with a brush. After drying, the low and raised portions are carefully polished with pieces of green schist, cut in forms either prismatic, conoidal, or cylindrical (Fig. 11). The operation described at the end of the last paragraph is then repeated. On the next day a soot varnish is made, and applied with a rat-hair brush. After another day and a half a charcoal polishing succeeds, the charcoal being first rubbed smoothly on pieces of schist and then applied. More polishing with schist powder and a rubbing with oil precede the painting of the lowered parts, for which purpose the *seshime* varnish mixed with oxide of iron and camphor is again used.

LAYING ON THE GOLD.

The designs are next painted with a rat-tail pencil (Fig. 12), dipped in filtered oxide of iron, *seshime* varnish. Then, if for instance a peony is to be represented, two kinds of gold powder and a gold scale (*yasuriko*) is used for branches and stem. To represent rocks and stones, pieces of metal flaked, and made of still another kind of gold powder (*hanako*), are employed. How these metallic preparations are made will be described farther on. Having thus ornamented the work, a

THE DEPOLISHING

consists in removing the polish on certain parts of the object where portions of the design to be painted in colors fall. This is done by rubbing with Honoki charcoal powder, followed by retouching with the rat-tail pencil. In the latter operation, a cup of buffalo horn (Fig. 16) is used, which is retained on the thumb by a cord. This cup contains a lacker, *seshime* varnish and iron oxide filtered five times through paper. Then the proper powder to give the color is placed in a goose-quill (Fig. 17), at the end of which is a very fine sieve, through which the powder is shaken in clouds over the wet lackered part, the excess being removed with a soft brush. The object is then left to dry.

PAINTING IN COLORED METALS.

The powders and leaves of metal used are always in harmony with the subject. To paint a river, for example, the shores are boldly traced with the rat-hair pencil, using the point to indicate the water (Fig. 18). Then with the feather a certain colored gold powder is sifted on, then a powder of different color, and, finally, here and there fragments of gold leaf are inserted. For a black ground, a smoke-black varnish is used, and the gilded parts are covered with a transparent varnish. After five or six days' drying, the black parts are slowly polished with powdered Honoki charcoal, then the gold is polished with camelia charcoal, then with horn powder, then rubbed with a wet cloth, then with a dry one. The piece thus prepared is covered with black varnish again, and the design is rubbed, dried, and the piece is put away for the night. Next day schist powder and oil are applied, and more rubbing with paper is done. On the following day the finger is the rubbing instrument, and another polishing with horn powder finishes the operation.

A gray groundwork is applied after the sub and intermediate lackering above described is finished, the parts being

previously depolished by the goose-feather apparatus, held as shown in Fig. 19, and rapped gently on the surface, so as to scatter the metallic powder. Then white flakes called *shiroq iraki* are gently passed over the parts thus gilded. *Nashyiraki* varnish mixed with camphor is then laid thinly on, polishing with camelia charcoal follows, then drying, and then another coat of varnish. After another drying, a number of small prisms of camelia charcoal are polished on schist wrapped in paper, and are rubbed over the surface until the groundwork shows. Then follows a series of varnishing and horn-powder polishing similar to that already described.

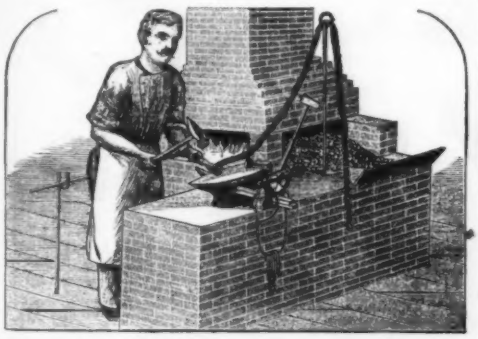
We have translated the foregoing from *La Nature* in some detail, in order that the reader may judge of the marvellous delicacy required for the work. At least a month is required for the simplest object, and when finished its weight in gold falls far below its actual value. The durability of the work when finished, in view of this very delicacy involved in its production, is marvellous. Not long ago a vessel, having in cargo some of these almost priceless lackers of the fifteenth, sixteenth, and seventeenth centuries, was totally wrecked near the Japanese coast. For two years the objects were submerged, and then divers recovered them. Despite the action of the sea water, the objects were uninjured, and several of them may now be seen at the Exposition, as beautifully brilliant as when they left the workman's hands.

When the Jesuit missionaries first sent specimens of Japanese lacker to Louis XV., Europe fairly rung with their praises. Huyghens, the great physicist, and Martin, the painter, exhausted every resource of science and art to reproduce them, and failed. Ever since the lackers have been known similar attempts to make *fac similes* of them have proved fruitless. Imitations, true, are plentiful; but their very cheapness proves them to have been produced by processes infinitely more simple than those which we have described.

CHAIN-MAKING.

AMONG the most interesting exhibits at the Fair of the Mechanics Institute, San Francisco, is the operation of chain-making, shown by the Pacific Chain Works. The *Mining and Scientific Press* says:

"There is probably no one industry upon our coast that is more difficult to establish on a fair paying basis than that of chain-making. The inclination of the average American to purchase any thing that 'will do,' provided it is cheap, and the extreme low price at which the prison-made chains of the Eastern States are offered in our markets, is the prime obstacle in the way. Where chain must be had to fit a wheel, or for special purposes, and where great strength is required without extra size being admissible, our local chain manufacturer must be called upon.



"The engraving represents the forge of the Pacific Chain Works in the machinery department of the fair, and has so far been the centre of attraction at this exposition, the crowd around it at all times being so great as to scarce admit of a sight of the workman without waiting a long time. He is engaged in manufacturing ordinary coil-chain, size three eighths inch, a leading size among hardware dealers. The same kind is also worked up into trace, back, pole, stay, and other kinds of chains. Old farmers and mill men often inspect the separate links one after another, to assure themselves of the integrity of the weld, and all express satisfaction. The quickness with which the work is done is a source of surprise to all."

HOW TO MAKE STEAM AND WATER JOINTS.

By JOSHUA ROSE.

No. 2.

THE gauze joint will answer equally as well for hot or cold water, even under high pressures, as it will for steam, providing that it is given time to properly set; otherwise it is apt to wash out, especially if the putty does not contain a large proportion of white lead. To aid the setting, a little copal varnish may be added to the mixture, but this should never be resorted to if it can be avoided; supposing the case to be, however, necessitous, we must proceed as follows: If varnish be added to white lead, ground in oil, and of the usual consistency, it will require the addition of so much dry red lead to bring the mixture to the proper consistency, that it will contain an insufficiency of white lead, and, in consequence, will not hold well together or spread evenly. To obviate this defect we may take a can of white lead ground in oil, in the form in which it is usually sold, and, after opening it, pour off the oil which will be found to have separated from the lead, and then add the varnish, bearing in mind that the varnish should not be mixed until the joint is all ready to make, because it causes the lead to set very quickly and become very hard.

For water-joints requiring to stand high pressure, and to be used as soon as made, the duck or canvas joint is the best. This joint is made by using, in place of the gauze wire, one or two thicknesses of duck or canvas, cut out to the size of the flange, and with the necessary holes to receive the standing bolts and leave the bore of the pipe clear. If the flange of the joint is of copper, brass, or wrought iron, or, if of cast-iron, is of sufficient strength to permit it, one disk of canvas may be made the full size of the flange, and a second may be made to have an external diameter sufficiently large to fit snugly inside of the bolt holes, which will form sufficient thicknesses if the flange is a fair fit to its seat; if it is not, however, three, or even four, thicknesses of canvas may be used, in which case at least one of them should fit inside the diameter of the flange across the bolt-holes, as described. Our canvas disks being prepared, we spread on the first one a thin coating of red lead putty, and then lay another canvas disk on, again adding the putty until the whole is completed. We then spread some of the putty around the hole of the seat and that of the flange, place the canvas in position and screw the joint up, tightening down the nuts until they bring the flange to an equal seating all around and not sooner on one side than on another, for in that case the red lead putty will be squeezed unevenly, and too much on the side screwed up to excess. The nuts should be screwed up very tight; the joint wiped off, the protruding canvas cut off, and the joint is complete.

For very rude and rough joints, whether used under pressure or not, we may make, for either water or steam, a joint as follows: Taking four or five strands of hemp, we saturate them with a coating of white lead ground in oil, applying just sufficient to make the fibres of the hemp cling well together. We then plait the strands and coat the whole rope thus formed with red lead putty, and place the strand around the hole of the joint, taking care that the ends lap evenly, so that the joint shall be of even thickness. It is better, however, to bend a piece of lead or iron wire to suit the size and shape of the hole in the joint, and then wind the hemp and red lead around the wire. And in cases where the flanges of the joint are sufficiently strong to have no danger of their breaking from the pressure due to screwing up the nuts, the piece of lead wire, if given a neat butt joint or neatly lapped, may be employed without any red lead putty or hemp; this does not, however, make a good permanent joint. In cases where a joint requires to be made thick to accommodate the length of the pipe, pasteboard may be used in the place of canvas, giving to it a thinly-spread coating of red lead putty on each side, and, if possible, leaving the pasteboard a trifle too thick and springing open the flanges of the joint to get the pasteboard into position without scraping the red lead putty off.

To make a rust joint, we proceed as follows: Into cast-iron turnings or borings we mix crushed sal ammonia and powdered sulphur in the proportion of 100 lbs. of turnings, sal ammonia 1 lb., sulphur ½ lb.; the whole to be thoroughly mixed and just barely covered with water.

If the joint to be made is a pipe for underground use, the end of one pipe is made larger than the other, and the one being inserted in the other, we first insert a strand of plaited hemp, driving it up with a calking-tool to the back of the joint; we then take the joint mixture and ram it up the joint, driving it at first lightly home with the calking-tool, and evenly all around. As the joint approaches being completely filled with the mixture, we may give the calking-tool harder blows so as to compact the mixture thoroughly. If the rust-joint is an ordinary or large one, we must make an iron ring or band and place it around the hole of the joint, and then bolt down the flange or plate upon the ring and proceed to fill and calk the joint with the mixture. It is possible to use plaited hemp instead of an iron ring, but it is not so efficient or reliable, as the calking may drive it through.

A rust-joint requires about 12 hours to set, and if this can not be given, the above mixture should be varied by adding ½ lb. more sal ammonia. The turnings should not be too large, and the mixture will be spoiled if left exposed to the air, so that it should be kept covered with water and mixed as soon before use as possible.

The objections to the employment of rust and red lead joints are manifold. They are not so sure as the scraped or ground joint, and, if they require to be occasionally broken, are much more expensive; they are a dirty and unsightly job when finished, and, if used under high temperatures, are very difficult to break open when necessary. In positions in which the nuts or bolts are liable to corrosion such joints are especially objectionable, although in many cases unavoidable, and a few observations upon breaking them will not be out of place.

If the nuts are so corroded that they will not unscrew with an ordinary wrench, we may, if the standing bolts and the wrench are strong enough to stand it, place a piece of gas or other pipe on the end of the wrench, so as to get a longer leverage; and, while applying the power to the wrench, we may strike the end face of the nut a few sharp blows with the hammer, interposing a set chisel, if the nut is a small one, so as to be sure to strike the nut in the proper place, and not rivet the screw end. If the joint is made with bolts we may strike the bolt heads with the hammer direct, using, as before, a light hammer, and sharp blows which will, in a majority of cases, start the thread, after which the wrench alone will usually suffice to unscrew it. If, however, this is not effective, we should take a thick washer, large enough in its bore to pass over the nut, and heat it to a yellow heat and place it over the nut, and the nut heating more rapidly than the stud or standing bolt, will be proportionately expanded and loosened; and, furthermore, the iron becomes stronger by by being heated, providing the temperature does not exceed 400°. If bolts are employed on the joint, the heating is still advantageous, for the increase of strength more than compensates for the expansion. In this case the heating, however, may be performed more slowly, so that the hole may also become heated, and the bolt, therefore, not made a tighter fit by its excessive expansion. So also, in taking out the standing bolts or studs, heating them will often enable us to extract them without breaking them off in the hole, which would necessitate drilling out the broken piece or part. If, however, this should become necessary, we may drill a hole a little smaller than the diameter of the bottom of the bolt thread, and then drive into the hole a taper square reamer, and then, with a wrench applied to the reamer, unscrew the bolt thread. If this plan fails there is no alternative, after drilling the hole, but to take a round-nosed cape or cross-cut chisel and cut out the screw as nearly as possible, then pick out the thread at the entrance of the hole, and insert a plug tap to cut out the remaining bolt thread. In English practice much of this trouble is avoided in the following manner: The standing bolts are made $\frac{1}{16}$ or ¼ inch larger in diameter at the standing than at the nut end, and the stud is made with a square piece in the middle, which square is a little less in length than the thickness of the flange of the joint.

By this means two ends are served: first, a wrench may be put upon the square to unscrew the stud or standing bolt, and next the latter is given additional strength to stand the torsion of unscrewing. It is also to be considered that at the inside end of the thread it terminates, in most cases, in a groove cut to the diameter of the bottom of the thread, and this forms a recessed neck, which is the weakest part of the bolt. This recessed neck stands, when the bolt is screwed home, at the entrance of the hole, and therefore in the very spot in which the bolt is liable to break off in unscrewing the nut. By the English plan, above referred to, however, this weak spot is removed to the outside of the square, so that if a breakage does occur the square will still be left, whereby to apply the wrench to unscrew the bolts. The objection to this plan is that the bolts must be made of square iron, and this involves the forging of each bolt separately; this in turn necessitates the turning of the bolts separately.

By leaving the studs round from end to end bar-iron may be used in their manufacture, and they may be turned in a monitor lathe, which is by far the cheapest method. Another objection to the English plan is that all the holes in the outer half of the joint must be made square, which is again an expensive process, so that all things considered round studs are the best; they should, however, be made $\frac{1}{16}$ inch larger at the standing than at the nut end.

To put standing bolts in their places we should use a wrought-iron socket, made square, to fit a wrench at one end, and drilled and tapped to receive the standing bolt at the other end. To prevent the thread of the standing bolt from binding in the socket, as it is apt to do, because the tap may not cut a full thread clear to the bottom of the hole, we may drill the hole in the socket a little deeper than would otherwise be necessary, and then take a piece of iron and screw it to fit the tapped hole in the socket; we then cut our piece of screwed iron about three quarters through its diameter, and screw it into the socket, so that on reaching the bottom of the hole in the socket it will bottom and break off, remaining in the hole a tight fit, and leaving a hole, tapped full thread along its entire existing length, and as a result the standing bolt will jam on the bottom of the hole and not on the sides of the thread, and will, therefore, release itself when turned backwards, and not come out at the standing end when the socket is unwound.

To take out a standing bolt, we take two nuts and screw them on the bolt end; we then hold the outer one still with a wrench, while we unscrew the inner one tightly against it. We may then remove the wrench from the outer or top nut, and unscrew the bolt by a wrench applied to the bottom or inner one. If the thread of a standing bolt has became damaged or burred, we can easily correct the evil by screwing a solid die or die nut down it, applying a little oil to preserve the cutting edge of the nut. Such a nut may be made by tapping a steel nut, and filing two or three slots through the thread, and then hardening it to a straw color. It is best, however, to tap it a little too large, if possible, because the thread becomes smaller in diameter from the process of hardening. The ends of standing bolts should be well rounded over, to prevent the end of the thread from becoming burred. If it is found impossible to take off a corroded nut without twisting off the standing bolt, it is the better plan to sacrifice the nut in order to save the bolt; and we may first hold a hammer beneath the nut, and take a cold chisel, and holding it so that the cutting edge stands parallel with the chamfered edge of the nut, and slanting it at an angle obtuse to the direction in which the nut in unscrewing would travel, strike it a few sharp blows, using a light hand-hammer; and this will often start it, especially if the nut is heated as before directed. The hammer held beneath the nut should be a heavy one, and should be pressed firmly against the square or hexagon side of the nut, the object being to support it, and thus prevent the standing bolt from bending or breaking, as it would otherwise be very apt to do. If this plan succeeds, the nut may, for rough work, be used over again, the burr raised by the chisel edge being hammered down to close it as much as possible before filing it off. By holding the chisel precisely as directed, the seating of the nut acts to support it, and thus aids the heavy hammer in its duty. If this procedure fails we may cut the nut off, and thus preserve the bolt.

To do this, we must use a cross-cut or cape chisel, and cut a groove from the end face to the seating of the nut—a narrow groove will do, and two may be cut if necessary; light cuts should be taken, and the chisel should be ground at a keen angle, so that it will keep to its cut when held at an angle, as nearly parallel to the centre line of the length of the bolt as possible, in which case the force of the blows delivered upon the chisel head will be in a direction not so liable to bend the bolt. The groove or grooves should be cut down nearly to the tops of the bolt threads, and then a wrench will unscrew the nut or else cause it to open if one, and break in halves if two grooves were cut.

After the nuts are all taken off, we may take a hammer and two or three wedges, or chisels (according to the size of the joint), and drive them an equal distance into the joint, striking one chisel first, and the diametrically opposite one next, and going over all the wedges to keep an equal strain upon each. If the joint resists this method, we may take a hammer and strike blows between the standing bolts on the outside face, interposing a block of hard wood to prevent damage to the face, and holding the wood so that the hammer strikes it endwise of the grain; and this will, in most cases, loosen the material of which the joint is made, and break the joint. If however the joint, after repeated trials, still resists, we may employ the hammer without the interposition of the wood, using a copper or lead hammer, if one is at hand, so as not to cause damage to the face of the work. To facilitate the entrance of the wedges, grooves should be cut in the joint of one face, their widths being about an inch, and their depth $\frac{1}{16}$ inch.

In drilling the tapping holes for standing bolts, it is the practice with some to drill the holes in cast-iron of such a size that the tap will cut three quarters only of a full thread, the claim being that it is as strong as a full thread. The difference in strength between a three quarter and a full thread in cast iron is no doubt practically very small indeed, while the process of tapping is very much easier for the three quarter full thread, because the tap may, in that case, be wound continuously forward without backing it at every quarter or half revolution, as would otherwise be necessary, in order to give the oil access to the cutting edges of the tap—and oil should always be used in the process of tapping, even though on cast-iron it causes the cuttings to clog in the flutes of the tap, necessitating in many cases that the tap be once or twice during the operation taken out, and the cuttings removed, because the oil preserves the cutting edges of the tap teeth from undue abrasion, and, therefore, from unnecessarily rapid drilling. With a tap having ordinarily wide and deep flutes, and used upon a hole but little deeper than the diameter of the tap, the cuttings due to making a three quarter full thread will not more than fill the flutes of the tap by the time its duty is performed. We have also to consider that with a three quarter full thread it is much easier to extract the standing bolt when it is necessary to do so, so that all things considered it is permissible to have such a thread, providing the tapping hole does not pass through into a cylinder or chamber requiring to be kept steam-tight; for in that case the bolt would be almost sure to leak. As a preventive against such leakage, the threads are sometimes cut upon the standing bolts without having a terminal groove, and are then screwed in as far as they will go; the termination of the thread upon the standing bolt at the standing or short end being relied upon to jam into and close up the thread in the hole. A great objection to this, however, is the fact that the bolts are liable to screw into the holes to unequal depths, so that the outer ends will not project an equal distance through the nuts, and this has a bad appearance upon fine work. It is better, then, in such a case, to tap the holes a full thread, the extra trouble involved in

the tapping being to some extent compensated for in the fact that a smaller hole, which can be more quickly drilled, is required for the full than for the three quarter thread. In tapping the holes in wrought iron, the tap requires a free supply of oil, and also to be turned partly back at about every half revolution, which enables the oil to reach the cutting edges of the tap and greatly relieves it, besides enabling it to cut smoothly and not jam. The depth of the tapping hole should be made if possible equal to one and a half times the diameter of the tap, so that in case the hole bottoms and can not pass through, the taper and what is called in England the second, and in the United States the plug tap, will finish the thread deep enough without employing a third tap, for the labor employed in drilling the hole is less than that necessary to the employment of a third tap. If the hole passes through the work, its depth need not be greater than $\frac{1}{4}$ inch more than the diameter of the bolt thread, which amount of excess is only desirable so that in case the nut corrodes, the nut being as thick as the diameter of the tap, and therefore $\frac{1}{4}$ inch less than the depth of the hole at the standing end, will be more likely to leave the standing bolt than to carry it with it when being unscrewed.

It is highly important that the tapping be performed straight, and, unless a guide and a long tap are used for the purpose, the machinist should try the tap shortly after it has entered by placing his square with the back against the face of the joint, and the blade along the thread of the tap. If then the tap leans to one side, he may correct it by placing more pressure on one end of the tap wrench than on the other. Having ascertained in what direction the tap leans, he should, instead of using the wrench all round the circle of its sweep, use it on one quarter only, and that quarter should be the one that will bring one end of the wrench over the part of the circle in which the tap leans; and by then placing the most pressure, and a little downward pressure (supposing the stud to stand upright), on the end of the wrench on the opposite side to that in which the tap leans, and by at the same time taking the wrench off the tap when a quarter revolution has been made, the tap will soon be righted. If, however, he finds it difficult to right the tap by this method, he should not take the wrench off at all, but move the tap a quarter revolution only back and forth several times, exerting the most (or all the pressure if the tap is over $\frac{1}{4}$ inch in diameter) pressure on the side already directed, and exerting it only during the forward of the reciprocating quarter movement, continuing the operation until the tap stands upright. If the hole is not tapped straight, that is to say, so that its centre line will stand at a right angle to the joint face, the standing bolt will lean, and as a result the holes in the flange will require filing out to allow the bolts to pass through. Then when the nuts are screwed up they will bed on one side only and will spring to suit the bedding face, and either bend or break the stud; while if the nuts corrode at all they are almost sure to break the stud, when the time comes that the nuts require to be removed. In this connection we may remark, that it is an English custom to place washers beneath the nuts, and in that event breakage from the above cause is much less liable to occur, because the washer will compress a little on the bedded side, and act to a certain extent as a cushion. It is the better plan, however, to tap the holes straight, whether washers are used or not. When washers are not used, the corners of the nuts are, on the bedding face, slightly chamfered off to prevent damage to the seating face—that is to say, the face of the joint flange; and this is especially requisite when the nuts are either hardened or case-hardened, especially if they are made of steel.

The wrench, or spanner, as it may certainly be more properly termed, should be a good, though an easy fit to the nut, so that it will not damage the corners of the latter.

RETORT SETTINGS.

In Scientific American Supplement No. 22 we gave a series of eight illustrations on this subject, to which we now add the following:

The engravings represent two different methods of setting five retorts in a bench, one method being illustrated in the upper, and the other in the lower figures. In both, the absence of transverse walls will be remarked—a system of setting to be recommended whenever good retorts, that will not break by the action of heat, can be obtained.

Fig. 1 is a front view, with half the front wall removed for the purpose of showing the interior. Fig. 2 is a longitudinal section, and Fig. 3 the plan with the arch removed.

The two lower retorts are placed upon the flues, *o*, which extend from within a few inches of the front wall to the vertical flues communicating with the main flue, indicated in plan on Fig. 3, and by the dotted lines on Fig. 2.

The upper side retorts are supported by fire-clay saddles, or quarries, placed at intermediate distances, the spaces between them being filled throughout with soap bricks, or brick on edge, according to the width of the space. By these means the current of caloric is prevented from passing at these points. There is also another line of bricks placed between the retort and the arch, marked *h*, extending from the front wall to within a foot of the back wall, thus leaving an orifice of that length at each side for the passage of the current. These are not shown in Fig. 3, in consequence of the section being below that point.

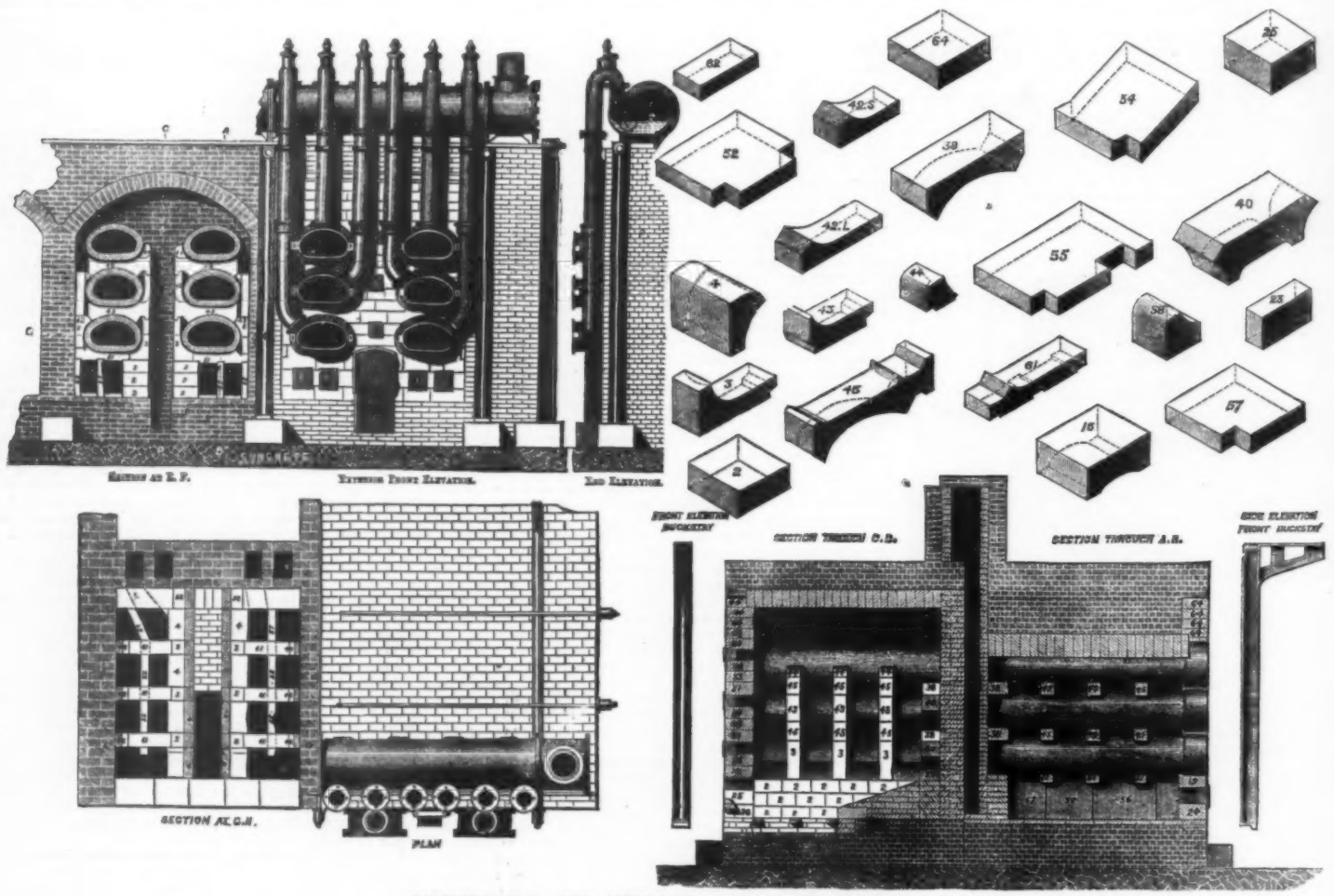
The heat, as generated in the furnace, F, is conducted directly to the whole of the retorts, the lower ones being protected at the point C from its most vivid action. The current of heat passes in the direction of the arrows, through the orifices at the ends of the partition, *h*, returns into the space, *b*, enters the flue, *o*, and thence passes to the vertical flues.

This setting is very economical as regards the consumption of fuel; but for its satisfactory adoption good retorts are, as we have already said, indispensable. The retorts are 21 x 14 inches by 8 feet or 8½ feet long internally, which dimensions and form, we believe, are most suitable for works of every denomination, as from their area they are capable of receiving large charges, and are easily drawn—two important considerations as effecting economy of labor in carbonization.

The second method differs slightly from the first, and is one which has been adopted by a gentleman in the North, whose carbonizing accounts show a greater return upon the coal consumed than those of any other engineer of our acquaintance.

In Fig. 4 it will be observed that a large portion of the lower retort is exposed to the most vivid action of the heat, and although this, in our opinion, can not be recommended, we are assured that the retorts are not injured by this close contact with the fuel. This is a theory which is supported by a well-known engineer of ability, who states that, under like conditions, the coal within the retort tends to preserve it, by the quantity of caloric being continually carried off by the gas.

The principal difference between this setting and that first described consists in dispensing with the piers for supporting the top retorts, which repose on slabs shown in section Fig. 5, and in plan Fig. 6. These slabs are laid on the upper retorts, leaving a space of about 18 inches long at the end. There are also partitions between the lower retorts as well as at the sides, so arranged that the current must pass to the end of the slabs before it can return to the flue, *o*. The action being, with one exception, identical with that described, need not be repeated. That exception is, that whereas, according to the first system, the current passes from the flue *o* to the vertical flues, in this it passes at once to the main flue, without the intervention of a damper.—*Journal of Gas Lighting.*



METHODS OF SETTING GAS RETORTS.

IRON AND STEEL MANUFACTURE.

By W. Mattieu Williams.*

The most interesting and important of all the oxidizing processes is that now so well known as the "Bessemer" process. It is a curious example of a great success achieved in spite of failure. Mr. Bessemer started upon the idea that the puddling process is merely one of oxidation; that by simply blowing air through melted pig he could do all that the puddler does; and more than this, that he might stop halfway, or at any other stage, and thus produce steel of any degree of hardness. He overcame all the mechanical difficulties of carrying out this idea; did blow the air fairly and bodily through the melted pig; did oxidize successfully, so far as silicon and carbon are concerned; but there he stopped. The sulphur and phosphorus stubbornly remained, and his iron was worthless. He struggled with this difficulty for some time, under discouragements that would have baffled most men. A great deal of public attention was directed to his invention, and he was especially assailed by a class of men who are about the most ignorant and insolent of any in existence. I mean those who "pooh-pooh" and sneer at every innovation, every aspiration for human advancement, every project of every inventor, and then, when any of these fail, they assert their own superior wisdom by the vulgar and detestable shout of "There, didn't I say how it would be." Seeing that at least three such projects out of every four are failures, any insolent fellow, however ignorant, may be right three times out of four, provided he is so utterly incapable of discrimination as to denounce at random every suggested innovation.

This preliminary failure of the Bessemer process, when properly studied, is very instructive and important. It clearly pointed to a fallacy, which was not merely Mr. Bessemer's, but which he held in common with all the most eminent metallurgists of the time. This fallacy once cleared out of the way, the course to be adopted was obvious enough. If the sulphur and phosphorus of ordinary pigs are not removable by mere oxidation, can any extraordinary pigs be found or made that are sufficiently free from them to be available for this blowing process? An answer to this question was found by the ironmasters of the Cleator hæmatite district. They made, and are still making from red hæmatite ore a superior class of iron—iron commercially known as "Bessemer pigs."

The following is a statement of the average results of my own analyses of thirteen brands of Bessemer pigs in actual use at the Atlas Works, Sheffield. It may be instructively compared with the analyses of a common Cleveland pig, and with the average of thirty high-class ordinary pigs that I gave in the third lecture. All these analyses being made and stated in similar manner, are strictly comparable.

Average Composition of 13 Brands of Pig-iron, made and used expressly for Bessemer purposes.

Combined carbon....	0.47	Total carbon, 3.19
Graphitic "	2.72	
Silicon.....	2.84	
Phosphorus.....	0.08	
Sulphur.....	0.14	
Manganese.....	0.90	
Iron by difference...	92.85	
	100.00	

Comparing this with the other analyses, it will be seen that the Bessemer pigs (the average given is of all the pigs actually used during a period of two and a half years, and

* From a lecture before the Society of Arts.

these of the mill forge the same) contain more carbon and more silicon than ordinary pig-iron, little more than half the quantity of sulphur, and less than one fourth of the quantity of phosphorus—this by comparison with a long average of high-class and high-priced pigs used for making the superior quality of armor plates, etc., for which the Atlas Works were celebrated. If we compare with common, low-priced Cleveland pig of the analyses No. 2, we find silicon and carbon still in excess, sulphur as before, about one half, and only one sixteenth of the quantity of phosphorus. These differences are very significant: the pigs have not been selected on any theoretical grounds, but have fallen into their places by a process resembling natural selection, which here, as in the animal and vegetable world, has determined the survival of the fittest.

By using such pigs as these, Mr. Bessemer overcame the defects of his first specimens—the cracking under the hammer—and obtained fair samples of mild steel; but then another difficulty started up. He found it practically impossible to regulate the quantity of carbon left behind, and therefore could obtain no reliable steadiness of results.

This difficulty was effectually overcome by an invention of Mr. Robert Mushet, which he secured by a patent dated September 22d, 1856, but which he eventually lost by failing to renew, as the law demands, at the end of the first three years. I am told that the instructions and remittance which he sent to his patent agent arrived but one day too late. This valuable invention thus fell into the lap of Mr. Bessemer free of cost; but I believe I am not committing any breach of confidence in stating that Mr. Bessemer has honorably acknowledged his obligations to Mr. Mushet's ingenuity, by an offering in the shape of a very acceptable annuity. This, however, I only have on hearsay, but can not refrain from mentioning it as a set-off against the treatment which Mr. Cort and others received from the wealthy ironmasters who fattened upon their inventions.

This invention of Mr. Mushet overcame the difficulty of irregular composition, and some other collateral difficulties presently to be explained, by fusing cast-iron very rich in carbon and exceptionally free from phosphorus, and pouring it into the melted iron from which all or nearly all of the carbon had been burnt out by the blowing. The composition of the carburetted iron being known, that of the resulting mixture could easily be determined by the quantity added.

The highly carburetted iron selected by Mr. Mushet for this purpose, and still used, is that known as "spiegeleisen," or mirror iron, from the brilliancy of its crystalline fracture. It is the whitest of white iron, and, besides containing an unusually large proportion of combined carbon, is especially rich in manganese, its value for this purpose being thereby much increased. It was originally made from spathic iron ore, sparry carbonate of iron found in Sweden, Styria, etc., and was imported, but is now produced in this country.

The following is the average composition of four brands which were in use during about two and a half years at the Atlas Works, and which I analyzed at different periods—that is, by samples taken from different deliveries:

Combined carbon...	4.20	Total carbon, 4.62
Graphitic " ...	0.42	
Silicon.....	0.93	
Phosphorus.....	0.06	
Sulphur.....	0.17	
Manganese.....	6.63	
Iron by difference...	87.59	
	100 00	

The present mode of carrying out the Bessemer processes is, first, to melt the pig-iron in a cupola, which communicates, by means of a trough, with the converter. This converter, shown in section by the diagram, Fig. 1, is an iron vessel lined with fire-clay or "ganister," and has a flat circular bottom, which is made removable, as it requires frequent renewal.

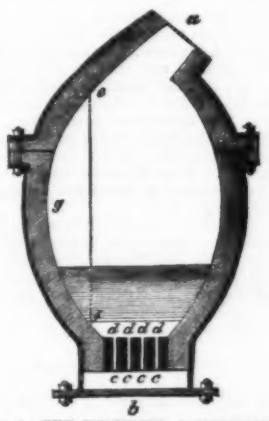


FIG. 1.—THE BESSEMER CONVERTER.

This bottom is fitted with fire-clay cylinders shown as *c d*, *c d*, *c d*, *c d*, and each cylinder is perforated from end to end with several holes of half to three quarters of an inch diameter. The bottom is thus riddled with sixty, seventy, or a hundred or more of such holes, according to the size of the converter. These communicate, by means of an air chamber *c c c c*, with a powerful blowing machine. This converter is mounted on an axis *i*, upon which it may be turned by suitable machinery.

When about to be charged, the lining is made red-hot, by burning coal inside, and the converter is bodily turned over until the line *e f* is horizontal. The trough from the melting furnace is then adjusted to the mouth *a*, and the melted pig-iron is run in, and lies in the belly of the converter below the line *e f*.

When so charged the blast is turned on, after which the converter is turned over to the position of the diagram, and the melted metal of course stands on the bottom over the hundred holes. It does not, however, run down these holes, as the pressure of the blast is more than sufficient to support it, by driving the melted metal upwards faster than gravitation can carry it downwards. If the blast was checked for a moment the fused iron would run through those openings, solidify below, and do serious mischief.

The "blow" has now commenced; the hundred streams of air are tearing through the pool of melted metal, and a huge flame roars furiously from the mouth of the converter. With this flame magnificent cascades of brilliant coruscating sparks are belched forth at irregular intervals, and the dazzling spray as it dashes against the flame-shaft rebounds with redoubled splendor, each glowing globule bursting with brilliant scintillations.

These globules may be collected on the floor below, and, when examined with the microscope, are found to be miniature bombs or hollow spherules that have burst, and are either shattered into fragments or merely perforated by the explosion.

The blast still roars on monotonously, and the flame steadily increases in size and brilliancy, attaining its maximum at the end of about ten minutes. This continues, with but little variation, for five or ten minutes longer. During this period its splendor is painful to the eye, and yet so fascinating that few who see it for the first time can resist it and turn their dazzled eyes away. The spark eruptions continue their spasmodic outbursts, but their appearance has curiously changed; they no longer appear to be red-hot, nor yellow-hot, nor white-hot, but curiously purple. This is probably an optical illusion, due to the dazzling impression of the flame, which is sufficiently strong to make all ordinary gas-lights appear red and smoky, and even to modify the appearance of sun-light.

Presently the flame contracts, the converter turns over deliberately, and the uninitiated spectator is startled by a new display, for in the course of this turning, the blast, instead of rising through the whole depth of metal, cuts obliquely through the superficial layer of floating cinder, and dashes it forth in a splendid eruption of sparks, which the rotation of the converter spreads out into a fan-shaped cascade of fiery hail, extending from end to end of the building.

Another trough is now swung round to the mouth of the converter, and from this the charge of spiegeleisen is poured. A violent ebullition commences immediately it mixes with the melted metal that has been blown, and a great waving flame of burning carbonic oxide silently pours out of the mouth of the converter. Whence comes this carbonic oxide, and why this agitation? I have endeavored to reply to these questions, by analyzing samples of the iron taken from the converter at the end of the blowing, and before the addition of the spiegeleisen. They were not free from combined carbon, but contained from one tenth to one quarter per cent, and also contained a considerable quantity of entangled particles of oxide of iron. It was burnt iron. While the quantity of carbon was considerable, the iron was protected from burning, even in spite of the intense activity of the blast; but, as this diminishes, its power of protection is lost, and oxidation of the iron itself commences.

The action of the spiegeleisen on this burnt iron is easily understood; the particles of oxide are reduced by the redundant carbon of the spiegel, and thus the carbonic oxide flame is produced, and hence the furious ebullition, as the evolution of carbonic oxide is proceeding throughout the whole mass of melted metal.

The Bessemer metal is now made, and is cast into ingots of the size that may be required, by first pouring it from the converter into a "ladle," a lined pot capable of holding the entire charge, usually five or six tons—sometimes double this quantity. The ladle stands on one end of an oblong platform, which until lately swung round over a semicircular line of ingot moulds, and by means of a movable plug in its bottom was made to fill ingot after ingot in turn as it came over them. Now, however, the usual practice is to connect all the ingots with each other from below, and thus, by pouring into one, all are filled from below. This not only saves some waste of metal, due to occasional leakage of the plug while passing from one ingot to the next, but it improves the quality of the metal, by clearing it of entangled air-bubbles and of adhering cinder.

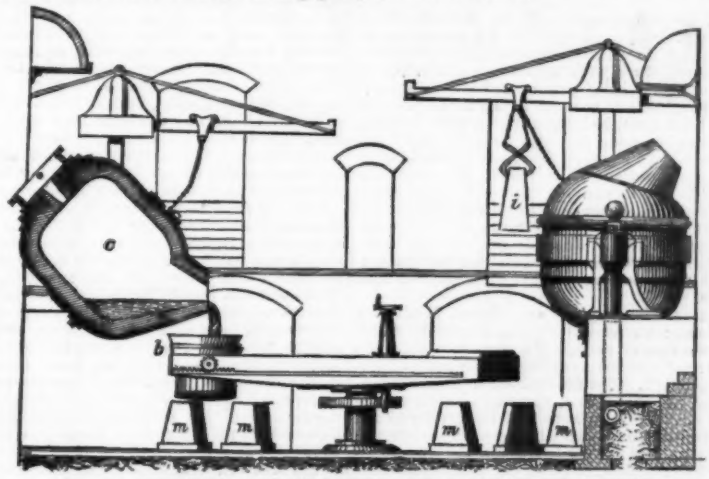


FIG. 2.—GENERAL ARRANGEMENT OF A BESSEMER HOUSE.

The following are the changes which take place during the blow. The evidence of these changes was obtained mainly by making a series of analyses of the contents of the converter at different stages.

First, the silicon and manganese are oxidized, and simultaneously the graphitic carbon is converted into combined carbon. (No. 1 gray pigs were used in all the blows that I examined.) Fusible cinder is formed by the silicic acid and oxide of manganese. As the quantity of uncombined silicon diminishes, the oxidation of the carbon commences, and goes on increasing, reaching its maximum when the flame is the brightest. It thus appears that the silicon, and possibly the manganese, by their greater affinity for oxygen, protect the carbon from oxidation while they exist in considerable quantity. In like manner the carbon, until it is reduced to about a quarter per cent, protects the iron from rapid oxidation. A certain amount of oxidation does, however, take place, even in the earlier stages, as shown by the cinder and the sparks; but, unfortunately, sulphur and phosphorus remain practically unmoved. (This applies to the quantities existing in fair samples of pig-iron. Very large proportions of either would probably be reduced by oxidation of the excess.) All this oxidation is, of course, attended with a corresponding evolution of heat, the amount of which may be estimated by considering the following figures:

With a charge of six tons of pig containing the average proportion of carbon, silicon, and manganese, the absolute weight of effective fuel they form amounts to about 8 cwt. This quantity is burned in the course of about twenty minutes, within the small space occupied by the melted metal in the converter. Such being the case, we need not be surprised at the effectual fusion of the mild steel, and even the nearly pure iron.

The importance of Mr. Mushet's invention, and the action of the spiegeleisen, will now be understood. Suppose, for illustration sake, we have a sample of spiegel containing 5 per cent of carbon, a charge of 5 tons of pig, estimated to be reduced to 4½ tons of blown metal, and we require steel for rail or tires containing ½ per cent of carbon. By adding half a ton of the spiegel, this is attained, supposing none of the carbon is lost, or that the small residue of carbon in the blown iron is sufficient (which is usually the case) to compensate for the carbon consumed in reducing the granules of oxide before mentioned.

The proportion of carbon in the resulting steel may thus be regulated with some approach to accuracy, though occasional discrepancies of practical magnitude sometimes occur. These are checked in all well-regulated Bessemer works by casting a small testing ingot from every blow, numbering this, and sending it to the laboratory, where, by a very simple and effective method of analysis, devised by Professor Eggertz, the percentage of carbon is tested. I have not time to describe this process, but may say that with practice it may be so expeditiously conducted that my assistant at Sheffield ordinarily made thirty, frequently as many as forty, carbon determinations, and sent in three copies of reports upon them between 8.30 A.M. and 2.30 P.M., getting his dinner in the meantime. The practical value of this is so great that, judging from my own experience, I doubt whether the Bessemer process would have attained to one half its present extension without it.

The spiegeleisen appears to do something more than merely supply the carbon in due proportion. It somehow improves the quality of the steel, and there is every reason to believe that this improvement is due to the manganese of the spiegel, but how it acts is still an obscure problem. It may be by washing out the residual silicon with which it so readily combines. The steel is rendered "cleaner" by the aid of the manganese.

At one time it was supposed that the best steel contains an alloy of manganese, as the Sheffield maker of pot-steel adds oxide of manganese to his blister steel when he melts it; but analysis has proved that the best finished steel contains no manganese. The steel-maker tells us that the oxide of manganese which he adds "throws up a cinder," that is, a silicate, which floats on the surface of the melted steel.

I have tried a good many experiments on the action of manganese upon iron and steel, and am still in the dark respecting it. I have used it by adding oxide of manganese to the fettling of puddling furnaces, and have improved certain kinds of iron thereby, especially the steely iron, or "puddled steel," as it is called, which is made by damping the fires, and balling up rather prematurely, but I have not found the manganese itself in the finished iron thus improved. It existed in small quantities in the puddled bar, but disappeared in the course of working. This leads me to suspect that it operates by giving increased fluidity to the cinder, and thereby rendering it more easily separable, thus producing a cleaner iron or steel.

The general arrangement of a Bessemer house are shown in the diagram, *Fig.* 2, where one of the converters, *c*, is in section, and turned over to pour into the ladle, *b*; the other converter (they are usually worked in pairs) is shown upright. The ladle is set on a platform, turning on an axis according to the old arrangement, where it was swung round over the mouths of the moulds, *m m*, some of which are shown, but their semi-circular arrangement is not well displayed. The moulds, which are open at the bottom, spread out downward, and the ingot is correspondingly thicker at the lower part. The object of this is that the moulds may be lifted off the ingot, which rests on a sand bottom of the floor. The crane and tongs for lifting the moulds and ingots are shown in the background; that on the right-hand side is carrying an ingot, *i*, by means of the self-acting tongs, which are hanging from a bracket that runs on wheels along the arm of the crane. The cranes, the converters, the ladle, etc., are all moved by hydraulic machinery.

The cost of Bessemer steel is about one fourth of that of the Sheffield pot-steel, which it resembles in the important quality of homogeneity. It is nevertheless unfit for the chief purpose to which the Sheffield cast steel is applied, that of the manufacture of edge tools and good cutlery. Ordinary Bessemer steel will not bear more than about three-fourths per cent of carbon; with a larger quantity it cracks or crumbles under the hammer. I have studied this subject with much care, aided by my friend the late Mr. George Brown, who was the first to carry out successfully, on a commercial scale, the manufacture of Bessemer steel. By analyzing the samples of pig delivered at different times, and comparing the quality of steel produced from them, I found that the more phosphorus the pig contained the less carbon the steel would bear. In one case the steel was rotten with only a half per cent of carbon, and the pig was returned. In another case, with an exceptionally fine "Cleator" pig, containing but a trace of phosphorus, and with superior spiegel, Mr. Brown succeeded in making tool steel of very fine quality, and containing nearly 1½ per cent of carbon.

The most extensive application of Bessemer steel is to the manufacture of rails and tires for railway carriage wheels. These should contain about one tenth per cent more of carbon

than the rails upon which they run. If the tires are softer than the rails, or even of the same hardness, they rapidly become grooved. If made too hard, they are dangerously brittle. Ploughshares, and what in Birmingham are called "steel toys," that is, hatchets, hammers, pincers, etc., a multitude of rough, coarse tools, and much bad cutlery, are now made from Bessemer steel; and besides these, it is occasionally used for boiler plates, and for structural purposes, such as steel bridges, roofs, etc.

The advantages it offers for the latter purposes are, its homogeneity and its greater tenacity as compared with iron. The latter quality enables the architectural engineer or the boiler-maker to obtain the required resistance to a given strain with an expenditure of about two-thirds the quantity of metal, thus combining lightness with stability, a most important desideratum.

Steel boilers and steel structures are, however, liable to a very serious objection. I have already stated that the quality of Bessemer steel is very materially affected by the quantity of phosphorus in the pig from which it is made. The phosphorus confers hardness like carbon (my own experiments indicate that a given percentage of phosphorus hardens about equally to three times as much carbon); all hardness is accompanied with brittleness, but phosphorus hardness with far more than carbon hardness. If, therefore, in the construction of a steel bridge, or steel roof, only one tie-rod, girder, or other important element of construction, were accidentally made from the metal of a bad blow, containing too much carbon, or from bad pig, the whole fabric would be endangered, as nothing is stronger than its weakest part. The same applies to boilers, where one brittle plate might give vent to a very serious explosion.

On this account the utmost caution is necessary in the use of Bessemer steel for such purposes, and skilful scientific testing is demanded.

ASTRONOMICAL NOTES.

Supposed Transit of Vulcan across the Sun.—In a letter to M. Le Verrier, M. Wolf announces that M. Weber at Peckeloh saw a round spot on the sun on April 4, at 4.25 Berlin mean time, which, if it were the supposed planet Vulcan, would follow M. Lescarbault's observation by 148 periods of 42.02 days. In these days of telegraphy it is a pity that use was not made of the convention with the telegraph companies, to communicate this discovery at once to observatories where photographs of the sun are regularly taken; and it seems strange that so many months should have been allowed to elapse before any notice was taken of the observation. Although the sun was without spots both on the morning of the 4th and of the following day, it is possible that a small circular spot may have broken out and closed up again rapidly. In the absence of all information as to the position and movements of the spot, any explanation, however, must be mere guesswork; but if a photograph can be found, taken near the time of M. Weber's observation, the question will be readily settled.

A Miniature Transit-Instrument.—In the Scientific Loan Collection at South Kensington is exhibited a portable transit-instrument by Steinheil, in which the telescope-tube forms the axis of the instrument, the rays of light from a star being reflected into it by a right-angled prism fixed outside the object-glass and turning with it so as to sweep in the plane of the meridian, the telescope-tube lying east and west. A somewhat similar instrument on a very much smaller scale has now been constructed by Steger, of Kiel, and is described by Dr. Peters in the *Astronomische Nachrichten*. The whole fits into a box six inches square, and is a marvel of compactness; but it is a question whether an ordinary sextant would not serve the purpose of determining time better, as the adjustments of a small transit are not easily determined with accuracy, and are very liable to disturbance, so that portable instruments are apt to become mere toys unless handled with extraordinary care.

Personal Equation.—Sixty years ago, Bessel found that there was a systematic difference in the observation by different observers of the time of passage of a star across the wires of a transit instrument, and to this difference the name of personal equation was given. The determination of this correction has long been recognized as a question of great importance, especially since the application of telegraphy to the determination of longitudes reduced all other errors to comparatively small amounts. In a paper read before the Irish Academy, Mr. Dreyer has discussed the various experiments that have been made on this point, and has collected a large amount of information on the subject. The difficulty of explaining the origin of this error still remains, though some light is thrown on it by physiological experiments on the rate at which nerve-sensations travel, and the time required to produce an impression on the brain. At first sight it might be supposed that the employment of two senses—the eye in noting the place of the star, and the ear in listening to the beat of the clock, or to the tap with the contact key made by the observer in the chronographic method—might have much to do with it, as there might well be error or personality in comparing two different kinds of sensations; but the same error is found when only one sense is concerned, and M. Wolf, of Paris, concludes that personal equation is to be referred partly to a habitual error in bisecting an object, and partly to the persistence of impressions on the retina, which allows the mind to refer a moving object to any part of the path through which the body moved during the duration of the impression. In fact, according to this view, the real image of a star would be a line of length representing the motion in about an eighth of a second, and by a mental process the star would be referred to one end or other of this line. These and other results have been obtained by means of contrivances of various kinds, in which an artificial star can be made to cross the field of view, the exact instant at which it passes each of the wires being known and compared with the times recorded by the observer, so that the absolute error of his observations is known. In the observations with real stars it is only the difference between two observers which can be found, and there is no deciding which is most in error. The amount of the error is surprising when it is considered that skilled observers are concerned, who can be relied on not to vary more than a twentieth of a second either way in their habit of observing. Thus Bessel found that his personal equation (as compared with other observers,) gradually increased in a long course of years until it exceeded a whole second of time; and, even with the chronographic method of observing, differences of three quarters of a second are frequently met with. It was for a difference of this amount that Maskelyne dismissed his assistant Kinnebrooke, personal equation being then unheard of.

Photometric Experiments on the Light of Venus.—The principle of comparing the intensities of two lights by means of the shadows cast by them, which was introduced by Rumford, has been applied by Mr. Plummer to the determination of the brightness of Venus, his results being given in the *Monthly Notices*. Mr. Plummer found that the shadow cast by Venus was distinctly visible; and from a series of observations made about the time of greatest elongation, he concludes that the light of Venus at greatest brilliancy is about 1-800th of the full moon, and equivalent to that of a standard sperm candle at a distance of 247 feet. One interesting fact results from Mr. Plummer's measure—namely, that, like the moon, the surface of Venus is not smooth, since its brightness increases as it approaches the full phase much more rapidly than would be the case with a polished body. Mr. Plummer's observations, however, extend over too short a period to decide the question. From a long series of observations of the moon, Zöllner found that the increase in brightness indicated an average slope of 52° in the inequalities, great and small, of the surface, and it will be interesting to see whether similar results are found for other bodies. Mr. Plummer's conclusion would seem to show that the light of Venus is not derived by reflection from cloud in its atmosphere, but from the surface of the planet itself. It is worth mentioning that Mr. Plummer also succeeded in obtaining a shadow from Sirius.

Proper Motion of Spots on Jupiter.—On examining Jupiter on three successive occasions, at intervals of five and seven days respectively, Mr. Brett has remarked a pair of bright spots which showed such a striking similarity that he could only conclude that they were reappearances of the same objects. On comparing their positions, however, with those which would be given by the accepted period of rotation he found considerable discordances, leading to the conclusion that in the first interval the two spots had drifted forward at the rate of four minutes in each revolution, and in the second interval at the rate of seven minutes and a quarter, besides changing their relative positions. As Mr. Brett has inferred from the fact of these spots casting shadows that they are bodies of approximately globular form, there seems a little difficulty in explaining a drift, at the rate of 165 miles an hour, of globes of 6000 miles in diameter, which must be wholly immersed in the atmosphere, since they disappear as they approach the limb. At such a depth as 6000 miles, it is not easy to realize the condition of Jupiter's atmosphere, as the pressure must be enormous, especially considering that the force of gravity on Jupiter is two and a half times as great as on the earth. Mr. Brett's views are, however, supported by Mr. Burton, who has concluded that light can penetrate to a depth of 10,000 miles below the visible surface of Jupiter, and the small specific gravity of this planet tends to countenance this idea.—*Academy*.

MEETINGS OF SOCIETIES.

Entomological Society.—(London, Sept. 6.)

J. Jenner Weir, Esq., F.L.S., in the chair. Mr. Edward Saunders exhibited some recently-captured Hymenoptera and Hemiptera, many of them rare in this country, and made some remarks respecting the bug of the house martin, of which he had taken eighteen specimens on the window-sills of a house. Mr. Weir mentioned that on a recent visit to the South Downs he had suffered much annoyance from the attacks of harvest-bugs, as many as eighty pustules appearing on each foot. Several remedies were suggested, especially rubbing the affected parts with brandy and water; but Mr. Smith stated that on one occasion, when he was in the Isle of Wight, and exposed to their attacks, he had found that by taking a dose of milk of sulphur he was effectually relieved from all annoyance. Prof. Westwood communicated a note with reference to some shoots of horse-chestnut which he had exhibited at the July meeting of the Society, having been destroyed, apparently, by some lepidopterous larvæ or wood-boring beetles; but he had since received from Mr. Stainton some shoots that had been forwarded to him by Sir Thomas Moncrieffe, which had been destroyed by squirrels in precisely the same manner. Sir Thomas had himself seen the squirrels at work splitting the shoots with their teeth, and extracting the pith. Prof. Westwood also stated that he had received from a correspondent in Oxfordshire specimens of the two small species of grasshopper with long antennæ, *Meconema varium*, Fab., and *Xiphidion clypeatum*, Panzer, which he had taken on a pear-tree in his garden, where they had been regularly observed for the last five or six years. Mr. M'Lachlan said that the former insect was frequently observed by lepidopterists when sugaring for moths. Mr. Smith communicated the descriptions of three additional species of *Formicidæ* from New-Zealand, which had been sent to him by Mr. David Sharp since his description of Mr. Wakefield's collection was in the press. Two of the species belonged to genera not previously ascertained to inhabit New-Zealand—namely, *Am lyopone* and *Ponera*. The following memoirs were read: "Monograph of the Dipterous Genus *Systropus*, with Notes on the Œconomy of a new Species of that Genus," and "Descriptions of New Genera and Species of *Acroceridæ*." Both were communicated by the President, Prof. Westwood.—*Academy*.

PROFESSOR HUXLEY ON THE FALLS OF NIAGARA.

Professor Huxley, in his late address at Nashville, said: I know it is thought very often that men of science are in the habit of drawing largely from their imagination, but it is really not so. The most sober, careful consideration of facts forces upon you more and more determinedly the conviction that the theory respecting which we have this archæological evidence of a period of the past history of the world is of a duration which, in comparison with our human standard, may be regarded as almost absolutely infinite. Take, for example, the case of the cataract of Niagara, where I have been recently spending some time, so that I might fill myself with the grandeur and beauty of that extraordinary natural phenomenon; it is quite easy to see that the Niagara river has formed its own valley, has cut its way back through the plateau of rocks from which it falls for some six miles. There is not the slightest difficulty in seeing that. The great cliff from which it tumbles is formed of two kinds of rock—hard rock at the top and soft rock underneath. The water undermines the soft rock below, when the solid stratum above falls over. You can trace the gradual excavation of that valley for six miles from that marvellous bluff which, from Brock's monument, overlooks the plain of Ontario. Now, the rate at which that work is going on has not yet been positively ascertained, but we may be perfectly certain (I am now speaking largely within limits) that that work of cutting back does not go on at the rate of a yard in a year. We have six miles of such cutting, which will bring you to a period of 10,000 years for the cutting back of Niagara alone. It is an immaterial matter to me how many years it takes, but it would be nearer probability, much nearer the truth, if I had said three or four times that amount.

What relations does a period of that kind bear to the vast duration expressed by these vast ledges of strata which form the globe? We are a people curious enough to form a very distinct calculation of this. The sides of the ravine through which Niagara is cutting its way are formed by masses of alluvial matter, which must be older than the river which has cut through it. While in that alluvial matter you find the remains of shell-fish, undistinguishable from those which now inhabit the lake, and along with them you find—as has been found—the teeth of the mastodon, which we know from abundant evidence was an inhabitant of the continent of North America at a comparatively recent period, the very last step of that long series of changes, of which the limestone, upon which you are now standing, indicates one of the older ones.

Thus it follows that the whole work of Niagara occupies one period of this vast duration. In relation to our duration of time, that 10,000 years, or whatever else it may have been, is but an infinitesimal fragment of time, so far as the great phenomena of the globe are concerned. During that vast time the population of the globe has undergone a slow, constant and gradual change, one species giving away to another. We have passed by slow and gradual methods, without vast and sudden changes, into that state of things which obtains at present. I need not say that this view of the past history of the globe is a very different one from that which is commonly taken. It is so widely different that it is absolutely impossible to affect any kind of community, any kind of parallel, far less any sort of reconciliation, between these two. One of these must be true. The other is not.

JETHRO WOOD.

Jethro Wood, the inventor of the modern improved cast-iron plough, was born at White Creek, Washington County, N. Y., in 1774. Although previous attempts had been made to construct cast ploughs, his was the first that proved entirely successful; and through the excellence of his inventions, his unwearied labors to perfect its manufacture, and to introduce it among farmers, in connection with its cheapness and efficiency, he is justly regarded as the original inventor and successful introducer of the plough as now used by the farmers of the whole country; in the same way that to Fulton, the inventor of the present form of the steamboat, is due the credit of placing it successfully in general use.

Mr. Wood had his attention drawn to the construction of the plough in early life, and when only five years of age commenced his experiments. He melted his mother's pewter spoons to cast a mould-board of a little plough, and cut small buckles rom his father's harness to finish it; but his attempts were suppressed for a while by the punishment which followed. At a later period he pursued his experiments with unwearied assiduity, and in determining the best form for the mould-board, cut up bushels of potatoes in forming the miniature model. He found great difficulty in selecting material, and after many experiments fixed on cast-iron as the best. The shape of the mould-board was formed on scientific principles, every inch of the surface being made to bear an equal pressure, so as to wear alike on every part.

Mr. Wood obtained his first patent in 1814. He improved and finished the plough in its perfected form, as now used, in 1819, when the final patent was taken out, embracing all the essential points since adopted by the best ploughs of the present day, with their minor modifications. He found great difficulty, however, in the want of skill in the furnacemen, and was often compelled to mould the castings himself, as well as always to furnish the patterns at his own expense, as the foundrymen had no confidence in his success. Furnaces were few and small in those days. The cost of the patterns is said to have varied from three to seven hundred dollars a set. He met with the same difficulty among the farmers, and was often obliged to give ploughs away to introduce them. The prejudice against what was termed "pot metal" mould boards was universal. He travelled extensively, and sent agents to all parts of the country to bring the plough into use. He ultimately triumphed over difficulty and prejudice, and then looked for a return for his toil and expense; but the manufacturers refused to pay the premium, and he could not enforce his claim in consequence of the defects at that time in the patent laws. The years were thus consumed till the term for his patent had expired, and without benefit to himself. He procured a renewal, but died soon after, in 1834. Then followed the amendment of the patent laws, and expensive trials and suits for his children consumed the second term.

Since this eminently valuable invention has been thrown without restriction before the farmers of the country at large, its great worth has become appreciated, and its benefits in the aggregate have been estimated at millions. The late Secretary Seward justly remarked that "no man had benefited his country pecuniarily more than Jethro Wood, and no man had been as inadequately rewarded."

ELECTRO-MAGNETO PHOTOGRAPHY.

At a recent meeting of the Chicago Photographic Association, Mr. J. Smith exhibited some peculiar negatives. Taking one of the negatives he immersed it in a solution for a few seconds; after washing he placed it in another solution which was in a glass bath dish, giving all a chance to see the disappearing process, which was done most effectually; for when the negative was removed from the bath and rinsed, there was apparently nothing to be seen that had the appearance of an image. He then flowed the plate with another solution, bringing back the likeness, and to just the point wished, claiming that, by putting them through solutions Nos. 1 and 2, and reducing them all (good and bad negatives) to the same level, then with solution No. 3 he can bring them up to excellent quality. He can make a solar negative of an intense harsh one, or make a splendid negative for contact printing from a solar. The negatives were all served the same and pronounced by the many learned ones present superfine, the printing qualities being magnificent. The process as a whole was pronounced wonderful.

DYNAMOMETER TESTS OF REAPERS.

On page 681 we give a table of dynamometer tests of reaping-machines as made under the auspices of the Royal Agricultural Society, for which we are indebted to the *Engineer*. This table contains many valuable particulars useful for machinists as well as for the makers and users of this kind of mechanism.

PARTICULARS OF DYNAMOMETER TESTS OF REAPING MACHINES AT LEAMINGTON, AUGUST, 1876.

TABLE I. CLASS I.—*Reaping Machines, with Self-delivery in Sheaf, clear of the Horse-track.* CLASS II.—*Reaping Machines, with Self-delivery in Swathe, clear of the Horse-track.*

Name of exhibitor.	Catalogue number.	Price.	Weight empty in pounds.	Loads on wheels and pole with driver weighing 168 lb. mounted.			Construction.										Aug. 15 to 18. Trial II. on Dynamometer in No. 2 field, and subsequently on farm road. All machines set to cut at 4in. high.					
				On driving wheel.	On off-wheel.	At end of pole at 36in. above ground.	Right or left-hand.	Number of rakes.	Size of driving wheel.	Width over all with sheers down.	Effective width for cutting.	Depth of effectiv notches exposed in knives for cutting.	Distance between centres of fingers.	Material of fingers.	Full stroke of crank in inches.	Direction of thrust of crank.	Advance of machines in inches per single cut.	Speed in miles per hour.	Mean draught in pounds.	Side draught in pounds.	Mean width of cut in inches.	Draught in pounds per inch width of cut.	Draught running light on farm road.
Class I.		£ s. d.							ft. in. in.	ft. in.	ft. in.	in.	in.		in.		in.						
Hornsby and Sons ...	469	32 10 0	1215	1198	168	17	Right	6	2 6 ×8	8 1	5 3	1¼	3	Malleable cast iron steel-plated	5½	Upwards	4·1	2·307	198·5	20	59	3·36	62·2
Do.	466	34 0 0	1172	1098	242	0	Right	6	2 10½×7½	8 0	5 0	1¼	3	Malleable cast iron steel-plated	5½	Downwards	4·1	2·64	192·8	22·5	55·7	3·46	79·27
Do.	464	34 0 0	1231	1235	168	4	Right	6	2 6 ×8	8 2½	5 3	1¼	3	Malleable cast iron steel-plated	5½	Upwards	4·1	2·62	206·8	22	57·1	3·62	73·8
Do.	467	32 0 0	1140	1055	248	5	Right	5	2 10½×7½	8 1	5 0	1¼	3	Malleable cast iron steel-plated	5½	Downwards	4·1	2·81	193·4	26·5	57·1	3·39	71·7
Johnston Harrester Co.	378	33 0 0	1055	1024	179	20	Right	5	2 10½×6½	8 11	5 0	—	3		3	Downwards	4·1	2·62	186·2	19	58·2	3·2	82·0
Hornsby and Sons ...	463	33 0 0	1211	1195	186	2	Right	5	2 6 ×8	8 2	5 3	1¼	3	Malleable cast iron steel-plated	5½	Upwards	4·1	2·77	197·3	24·5	57·4	3·44	68·5
Class II. Hornsby and Sons ...	471	32 10 0	1155	—	—	26	Right	6	2 6 ×8	8 1½	5 3	1¼	3	Malleable cast iron steel-plated	5½	Upwards	4·96	2·77	201·1	16	57·6	3·49	81·8
Beverley Iron Co. ...	3150	40 0 0	1776	—	—	Drivers not mounted	—	—	2 10 ×4½	8 9½	7 0	1½	3	Malleable iron case-hardened	3	—	3·1	2·29	358·8	—	93	3·86	172
Hornsby and Sons ...	470	36 0 0	1445	—	—	43	Left	—	2 6 ×9	8 4	5 0	1¼	3	Malleable cast iron steel-plated	5½	Downwards	3·92	2·52	268·5	52·5	57·5	4·63	128·2

TRIAL I. in field No. 1, on wheat, August 14th and 15th. A clean upstanding crop, good, rather strong straw, bright and slippery, and about 3½ft. high. Ten machines in Class I. and three machines in Class II. were tried, and these machines here tabulated afterwards selected. TRIAL III. on barley in fields No. 3 and 4, August 16th to 18th. TRIAL IV. on heavy crop of tangled wheat, August 21st.

TABLE II. CLASS III.—*Combined Reaping and Mowing Machines without Self-delivery.*

Name of exhibitor.	Catalogue number.	Price.	Weight empty.		Distribution of load on wheels and pole when fitted as reaper, with man weighing 168 lb. and boy 124 lb. mounted.			Construction.										Trial II. on dynamometer, Aug. 16th and 17th, in field No. 2 wheat, and subsequently on farm road adjoining, all machines set to cut at 4in. high.					
			Fitted as a mower.	Fitted as a reaper.	On near wheel.	On off wheel.	At end of pole at 36in. above ground.	Right or left-handed.	Size of driving wheel.	Width over all with sheers down.	Effective width for cutting.	Distance between centres of fingers.	Material of fingers.	Full stroke of crank in inches.	Direction of thrust of crank.	Depth of effective notches exposed in knives for cutting	Advance of machine in inches per single cut.	Speed in miles per hour.	Mean draught in pounds.	Side draught in pounds.	Mean width of cut in inches.	Draught in pounds per inch width of cut.	Draught running light on farm road.
		£ s. d.							ft. in.	ft. in.	ft. in.	in.		in.		in.							
Hornsby and Sons	476	24 10 0	725	802	457	464	17	Right.	2 4	8 5	4 3	3	Malleable cast iron steel-plated	2½		1½	2·09		157	8	46·7	3·36	89·7
Do.	473	24 10 0	735	816	466	475	15	Right.	2 4	8 5	4 3	3	Malleable cast iron steel-plated	2½	Downwards	1½	2·09	2·51	143·6		43·4	3·31	94·3
Lewis and Locock	1031	22 0 0	735	815	473	458	13	Right.	2 2	8 0½	4 3	3	Malleable cast steel plate beneath	3	Upwards	2½	1·51	2·20	194·2	15	47·3	4·106	145·
A. Field and Co.	764	38 0 0	730	919	950	99	23	Left.	2 9	10 0½	5 2	3½		3	Downwards	1½	1·8	2·17	204·3	9	61·3	3·306	135·4
Bickerton and Sons	2454	26 0 0	900	954	612	460	33	Left.	2 7	8 9	4 6	2¾	Malleable cast iron	3½	Downwards	1½	2·21		179·5	10	32·4	3·425	133·3
Hornsby and Sons	474	24 10 0	741	822	453	500	15	Right.	2 4	8 5½	4 3	2 9/16	Malleable cast iron steel-plated	2½	Downwards	1½	2·09	2·33	136·6		45·9	2·97	33·2
Brigham and Co.	384	22 10 0	744	800	477	422	26	Left.	2 4½	8 6½	4 4	3	Malleable cast iron	3	Downwards	2	1·71	2·49	183·7	3·5	52	3·53	149·6
Hornsby and Sons	475	24 10 0	650	731	445	400	16	Right.	2 4	8 3	4 3	3	Malleable cast iron steel-plated	2½	Downwards	1½	2·09	2·36	141·8		45·7	3·10	73·4

TRIAL I. for excellence of work in wheat in No. 2 field, August 15th and 16th. TRIAL III. on barley in No. 3 field, August 17th and 19th. TRIAL IV. in sewage rye grass in No. 3 field, August 18th.
* A second run with quick crank speed.

TABLE III. *One-horse Reaping Machines.* CLASS IV.—*The power of one-horse Machines not to exceed 33,000 foot-pounds per minute, at or about 2½ miles per hour.*

Name of exhibitor.	Catalogue number.	Price.	Weight empty in pounds.	Distribution of load on wheels and shafts with man weighing 124 lb. mounted.			Construction.										Trial I. in No. 2 field (wheat) Aug. 14 and 15, on Dynamometer for qualification in draught.					Trial III. on Dynamometer in field 2 and on farm road adjoining. Four machines selected. All machines set at 4in. height of cut.				
				On near wheel.	On off-wheel.	At saddle chain on shafts.	Right or left-handed.	Arrangement for delivery and number of rakes.	Size of driving wheel.	Width over all with sheers down.	Effective width for cutting.	Depth of effective gaps exposed in knife for cutting.	Distance between centres of fingers.	Material of fingers.	Full stroke of crank.	Direction of thrust of crank.	Advance of machine in inches per single cut of knife.	Height of cut.	Speed in miles per hour.	Mean draught in lbs.	Foot-pounds of work p. min. at actual speed.	Foot-pounds of work per minute assuming mean speed of 2½ miles per hour.	Speed in miles per hour.	Mean draught in pounds.	Mean width of cut in inches.	Draught in lbs. per inch width of cut.	Draught running light on farm road.
		£ s. d.							ft. in. in.	ft. in.	ft. in.	in.	in.				in.										
Hornsby and Sons... ...	482	23 10 0	791	720	179	20	Right	Self-delivery with 3 rakes, all controllable	2 7½×6½	6 3	3 3	1¼	3	Malleable cast iron steel-plated	5½	Down	4·12	4	2·64	135	31320	29700	2·49	136	34	4	48·2
Brigham & Co.	385	17 10 0	738	591	323	73	Left	Manual back delivery	—	—	—	—	—	—	—	—	—	3½	—	189·8	—	41756	—	—	—	—	—
																		3½	2·56	175·7	39532	38654					
Mattison, W..	572	13 0 0	593	149	516	51	Left	Manual back delivery	2 5 ×6½	6 7	4 0	—	2¾	Malleable cast iron case-hardened	2½	Down	3·64	3½	—	119·4	—	26268	2·64	107·6	48·2	2·23	53·3
Hornsby and Sons... ...	479	16 10 0	546	175	459	37	Left	Manual back delivery	2 6 ×8	6 3	4 0	1¼	3	Malleable cast iron steel-plated	5½	Down	4·10	4	2·85	82·8	20783	18229	2·6	82·46	43·6	1·89	32·05
Do.	481	23 10 0	786	728	179	17	Right	Three rakes controllable, all or none	2 7½×6½	6 0	3 4	1¼	2½	Malleable cast iron steel-plated	4½	Down	4·12	4	2·53	130·3	29057	28666	2·26	142·9	32	4·46	53
Do.	480	16 10 0	565	138	516	31	Left	Manual back delivery	—	—	—	—	—	—	—	—	—	4	2·67	86	20392	18931	—	—	—	—	—
Mattison, W..	573	13 10 0	622	167	553	25	Left	Do.	—	—	—	—	—	—	—	—	—	3½	2·87	140·6	35572	30932	—	—	—	—	—
Hornsby and Sons... ...	478	16 10 0	595	186	486	46	Left	Do.	—	—	—	—	—	—	—	—	—	4	2·66	93	21762	20460	—	—	—	—	—

TRIAL II. for excellence of work on wheat, in field No. 2, August 18th. All machines tried except Brigham's, which was disqualified for draught as in Trial III. August 17th, TRIAL IV. on barley in field No. 3. The same machine

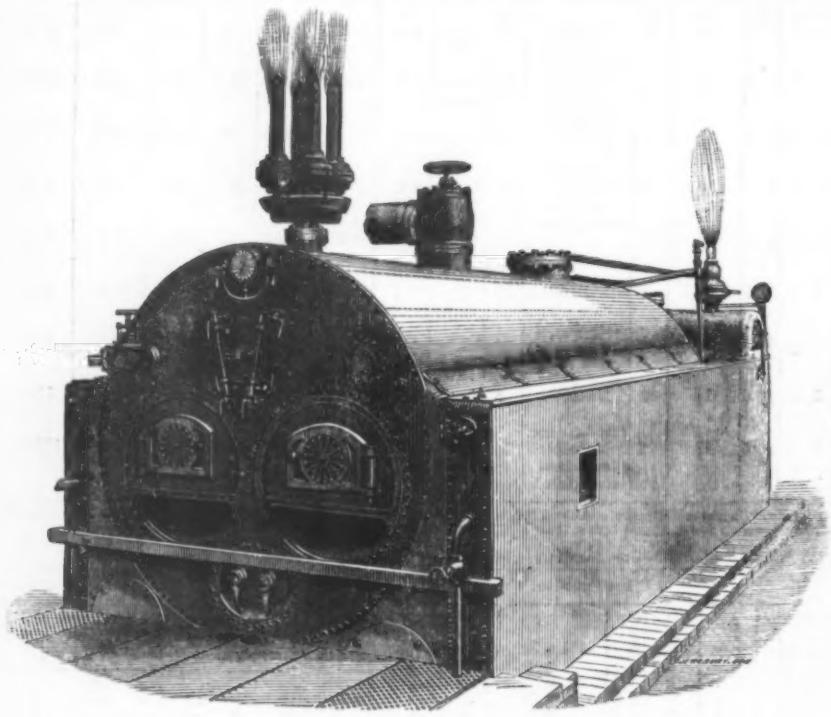
REILLY'S BOILER CASING AND SEATING.

Much attention has recently been directed to the economizing of fuel by the introduction of metal casings and seatings of steam-boilers, so as to utilize the whole of the heat produced by the process of combustion, the invention of James Reilly, Manchester, Eng. It need scarcely be explained that the casings and seatings of most stationary steam-boilers are at present constructed entirely of brickwork, taking long to build up, entailing great expense, and allowing when in use a great amount of heat to be lost; and to obviate these defects Mr. Reilly employs metal casings and seatings, forming metal chambers, containing water, in which the water is raised to boiling point before being supplied to the boiler. In one arrangement the casing in which the boiler is placed is formed of one or more parts, and consists of a hollow bottom, ends, and sides, the plates being kept at their proper distances apart by any required number of stays or ties, and to the hollow bottom he fixes hollow standards or supports forming the seatings of the boiler, and through these standards water circulates. The bottom of the casing rests on brick walls or other supports extending from one end to the other, and the front ends and sides are clothed with wood, felt, vegetable charcoal, or other non-heat conductor, and the bottom communicates with the ends, sides, and standards, there being in the back end a number of tubes through the metal casing, forming a large heating surface for arresting and absorbing the heat passing from the flues and under the metal bottom to the chimney.

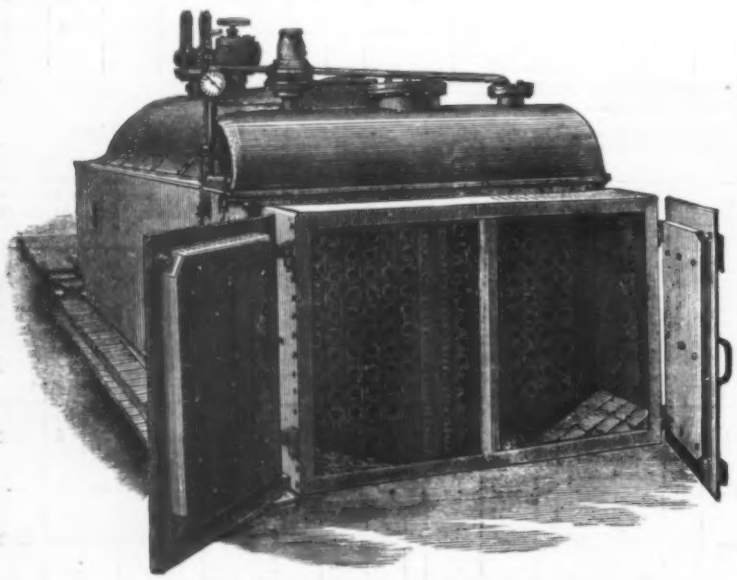
The exact nature of the invention will be readily understood from the above diagrams, of which Fig. 1 and Fig. 2 show the front and back view respectively, and Fig. 3 the front view of the boiler and casing combined and in use. It will, of course, be understood that the forms of the chambered casings and seatings vary according to the different forms of the boilers, whether used for manufacturing or domestic purposes; but in all cases the water in the spaces takes up all the superfluous heat which has hitherto been absorbed in the brickwork encasing and supporting the boiler, and, therefore, not only a great loss of heat is prevented, but the water is heated to a high degree, and can be either pumped or injected into the boiler or used for any other purpose; and when steam is generated in the hollow casing it is either forced into the boiler or boilers, or used in any other way required. In another arrangement he places at the sides and below the boiler a series of double pipes or tubes having passages for the circulation of the heat and spaces for containing water, and these pipes are connected to the ends and sides of the casing, and also communicate with the bottom and seatings, and when desired two of the pipes may be used as seatings for each boiler, and in another modification he places a number of pipes containing water in the flues, the water being heated for feeding the boiler or for other purposes. When two or more boilers are combined he causes, when desired, the heated air from the casing and flues of one boiler to pass to the flues and casing of a second boiler, and so on to a third or more, and thereby obtain the greatest possible effect from the combustion of the fuel, there being a fire in one or other of the casings when required to prevent condensation, and in all the arrangements he employs when required scrapers worked to and fro by any well-known means.

The claims to superiority which the arrangement possesses are very numerous, and comparative experiments have shown that a greater degree of economy is obtained than has been previously recorded, the amount of heat utilized approximating very closely to the theoretical heat contained in the fuel. It is also explained that a very considerable saving is effected in the space occupied by the boiler, and a much greater steam-producing power obtained from a boiler and casing constructed on this principle than from a boiler of similar size set in the ordinary manner. It is further urged that the boiler is greatly preserved, owing to the feed water being first passed through the casing and seating, where steam is produced at a pressure of 20 lbs., whereby a very large proportion of the impurities contained in the water are deposited in the casing before the water is pumped into the boiler, the deposit being readily blown off at any time. It is estimated that the actual work performed by the boiler and seating is from one half to two thirds more than could be done with an equal quantity of coal by the boiler alone if set in brickwork in the usual manner. The casing and seating, as well as the boiler, can be readily inspected at any time when not at work either internally or externally, and all parts are accessible for cleaning and repairs.

A public trial of the above was lately held at the patentee's works, Cornbrook, Manchester, in the presence of a number of scientific and practical gentlemen interested in the subject. The experiment was watched with the closest attention by several of those present, and the results carefully noted. On Wednesday the experiment was of 7 hours 35 minutes' duration, in which time 18,557 lbs. of water was evaporated. The boiler experimented on was an ordinary horizontal Lancashire boiler, 6 ft. 6 in. diameter and 18 ft. long, made by Plant & Co., of Miles Platting, and the coal used was Oldham Black Mine Burgy; the consumption of coal was 1330 lbs.; the area of grate surface was 24 square feet, the consumption of coal per hour and per square foot of grate surface was 8.4 lbs., and the temperature of the escaping waste gases 280°. The number of cubic feet of water evaporated per hour from the feed temperature was 37.51 lbs. and the number of pounds of water evaporated from 212° Fahr. by each pound of coal consumed was 13.76 lbs., so that the results were altogether very satisfactory. The boiler has been in regular use for the last three months, and has been inspected by a large number of persons interested in the economic generation of steam.—*Mining Journal.*



NEW BOILER CASING AND SEATING.

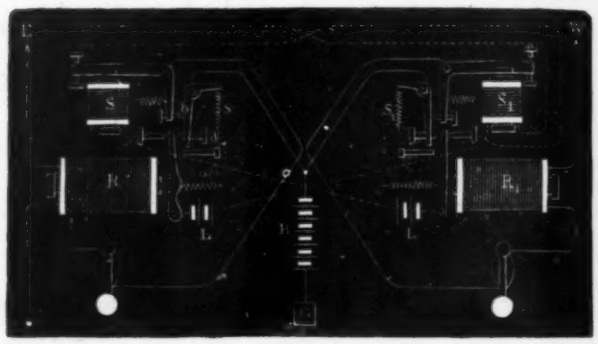


NEW BOILER CASING AND SEATING.

NEW TELEGRAPH REPEATER.

In the diagram both circuits are shown closed. It will be seen that the eastern relay works the sounder on the western side, and *vice versa*. Now let the western circuit be broken, the sounder S on opening breaks the eastern circuit at the point *b*, but before doing so a spring *s* draws the point *a* against the armature of the eastern relay, keeping its local points closed, and the sounder S_1 of course remains closed. On the western circuit being closed the sounder S closes the main circuit at *b*, and the eastern main circuit before the pressure of the point *a* is removed from the armature of the eastern relay. A spring contact at the point *b* would do away with the least possible kick, which might be experienced on high adjustments in its present form. With that improvement we see no reason why it would not prove practically the most simple, sure, and easily adjusted repeater in use.

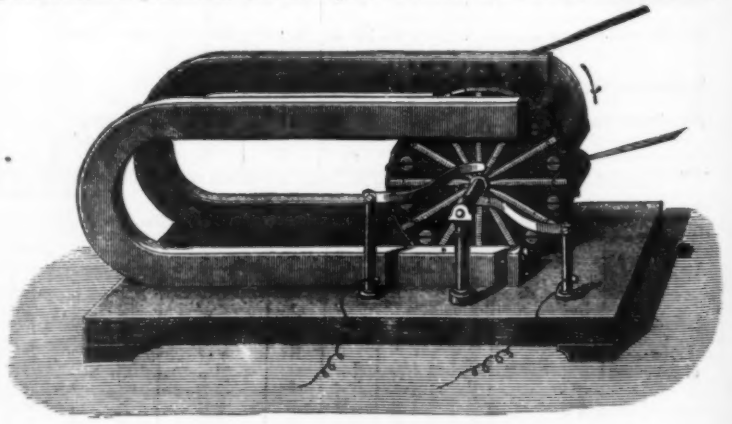
In working as two single sets Morse, it would be only necessary to loosen the springs *s* and s_1 to give the relay armatures free play.—*The Telegrapher.*

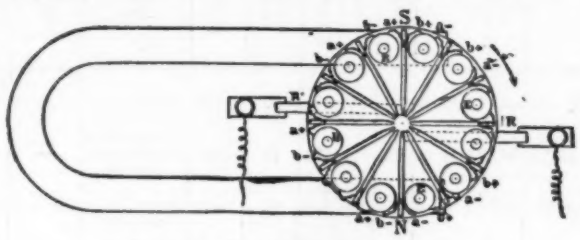


NEW TELEGRAPH REPEATER.

BREGUET'S NEW MAGNETO-ELECTRIC MACHINE.

The magneto-electric machine we illustrate on this page bears a close resemblance to that known as Clarke's induction apparatus. The English physicist caused two bobbins of insulated wire to revolve rapidly in front of the poles of a permanent magnet. Two currents alternately direct and inverse were induced in the rotating wire; and these, by means of a commutator, were made to flow always in the same direction. By increasing the rate of rotation, the number of currents induced in the wire in a given time was likewise increased, and thus a current almost continuous was generated. But however rapidly the currents were made they were not absolutely continuous. Mr. Alfred Niaudet Breguet recently commenced a series of experiments on the possibility of modifying the rotating bobbins so as to obtain a perfectly continuous electrical current. The experiments finally proved successful, and resulted in the machine which we illustrate to-day.





BREGUET'S NEW ELECTRIC MACHINE.

The bobbin or coil employed is similar in its general construction to that of the Gramme machine. However, there were several difficulties of detail that had to be overcome, and the appliances introduced to remove these embody the originality and chief merit of this new apparatus.

A circular disk is mounted on a horizontal axis; twelve bobbins are inserted in this disk in such a way as to resemble the floats of a paddle-wheel. The bobbins are connected together like so many elements of a galvanic battery, and thus they form one continuous length. The electrical condition of each bobbin when in movement may be inferred from Lenz's law—namely, that an inverse current is induced when a conductor approaches a pole of a magnet, and a direct current when it is withdrawn from that pole. Let the whole armature revolve in the direction indicated by the arrow in the figure. If we direct our attention to the bobbin adjacent to the pole marked N, we shall find that the current will be from a towards b; that is, the positive pole will be $a+$, and the negative pole $b-$. If we follow this bobbing during the semi-revolution from N to S, we shall find it to be traversed by a current from a to b; but during the other half revolution from S to N it will be traversed by a current opposite in direction to the former—namely, from b to a. What we have said of the bobbin adjacent to the pole N is true of all the others. It thus appears that all the bobbins on the left will be traversed by a current in one direction, and that all these in the right by a current opposite in direction but equal in volume to the former. The apparatus might not inaptly be compared to two distinct batteries consisting of six elements, each connected together for tension; it must now be plain that all that remains to complete the analogy is to unite these two batteries for quantity. This is effected by two metallic springs attached to two small uprights which are the terminals of the magneto machine. Twelve strips of copper are disposed radially, and to them are attached the two adjacent ends of every pair of bobbins. The metallic springs are virtually current collectors; and as they are always in contact with several of the radial strips, they must always be traversed by electric currents. Hence the perfect continuity of the current developed by this machine.

This apparatus would be found particularly serviceable in all cases requiring high tension but small quantity. In this respect, as well as in its smaller bulk, and the facility now afforded of constructing cylindrical bobbins with very fine wire, it may possess some advantage over the Gramme machine.—*Engineering.*

ARCHITECTURAL TREATMENT OF CONCRETE.

WE give a suggestive illustration for constructing and ornamenting a vault and colonnade in concrete, which was one of the diagrams exhibited by Mr. Payne in connection with a paper on concrete as a building material (heretofore published in SUPPLEMENT). The black lines at the angle of the columns show a light skeleton of T iron, which it is proposed to build up first, of sufficient strength only to support the moulding boards which are secured round outside, and grooved so as to keep the face of the concrete about half an inch back from the face of the iron to allow for plaster surface.

The small sunk panels at the top and bottom of capitals, to the bases, and running round the fans of the vaulting and interlocking domes, would be formed by moulds secured to the outer boards. The columns would be filled up solid with concrete, the vaults being kept as thin as possible for lightness—say from about 12 in. just above the caps, to about 4 in. at the centres. Wrought-iron concentric rings would be bedded in the thickness of these fans, to counteract any tendency to spread that might arise from cracks or flaws in the concrete, and which would entirely do away with the necessity of buttresses. After the moulding-boards were removed the surfaces would be brought up level with the iron, with stucco or cement work prepared for sgraffito; the first coat being made black or any desired color, and the finishing coat white, cut out with a tool in patterns to show the black beneath, as shown, and in the ordinary way.—*The Building News.*

DESIGN FOR A VAULT AND COLONNADE.
IN IRON AND CONCRETE
A LIGHT PERMANENT IRON SKELETON FOR SUPPORTING MOULDING BOARDS.
WROUGHT IRON CONCENTRIC RINGS BEDDED IN FANS TO RESIST SPREADING.
ORNAMENTED WITH INCISED WORK AND SGRAFFITO.

CHINA-CLAY—ARTIFICIAL FUEL.

IN the manufacture of artificial fuel Mr. F. J. Hamel, of Avenue road, Regent's Park, proposes in the first place to take china-clay, and, after bringing it to a dry state, reduce it to a powder, and either introduce it into the coal dust or other substances before or after he has prepared a solution of mineral or vegetable pitch, combined with resinous and fatty and oily matters, the whole being then agglomerated together; they are further mixed by the use of a pug mill or travelling screw, and as they travel or are in motion he applies jets of superheated steam to assist in the full amalgamation of all the ingredients. He next places the prepared materials in presses for solidification.

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MACCORD.

No. XXIII.

IT will be apparent on reflection that we may go one step farther in the process of changing the position of a body by revolving it around the three axes shown in Fig. 185; for as yet we have supposed but two successive revolutions to be made, and there is no reason why we should not make the third one afterward. And it may be necessary to do so too, for it is evident that there are positions into which a body can not be brought without it; but there is no position that we can not give the object by revolving it about the three axes, which operation gives a range of motions equivalent to that which could be obtained by suspending the body on a ball-and-socket joint.

In Figs. 200, 201, 202, 203 we exhibit these successive changes of position, using for illustration our rectangular prism, copying Fig. 144 for the last time, as representing it in its original or simplest relations to the paper, in Fig. 200. The front, side, and top views in each group are lettered A, B, C, respectively; and as before stated, in passing from one group to the next we find that one of these views is *copied* in a new position, and that the change thus made produces no effect upon one set of dimensions, if we may use that expression, in the other views. Thus, in Fig. 201 the view A is copied from Fig. 200, and the thickness, as $a\,e$, $c\,q$, is not changed; in Fig. 202 we copy the view B from Fig. 201, and find the breadths or distances from right to left in the front and top views to be the same in both groups; and finally in Fig. 203 we copy the view C from the preceding figure, and the heights are unaffected by this revolution about the vertical axis.

In Fig. 201 it will be observed that the lines which were originally horizontal are horizontal still, and are perpendicular to the paper in the front view. In Fig. 202 these conditions are changed, and none of the lines are horizontal, nor are the[re] perpendicular to the paper in any view, but the lines $a\,e$, $b\,f$, $c\,q$, [etc.] which were originally horizontal, still lie in planes which [are] perpendicular to the paper in the front and top views A and C. But in Fig. 203 even this is not the case; of course any one of the lines may be considered as lying in a plane perpendicular to the paper in any one of the views, but that plane will not be perpendicular to the paper in either of the other views. Also, it is to be noted that in Fig. 201 the lines $a\,d$, $b\,c$ are seen of their true length in one view only, instead of in two views as in Fig. 200, while the lines $a\,e$, $b\,f$, etc., are seen of their true length in two views; in Fig. 202 these latter lines still appear of their actual length, but in one view only, all the lines being foreshortened in both the other views; while in Fig. 203 the apparent length of all the lines is less than its real length in all the views, and all the angles, which we know to be in fact right angles, are distorted, and appear either acute or obtuse. We may mention here a common error, which consists in speaking of drawings of objects in inclined positions like those given the body in the last two figures, as *perspective* representations. In a sense the phrase might be justified, as they are really identical with the perspective drawings of the object as seen from an infinite distance. But the proper and technical use of the word perspective is with reference to drawings made from a point of view *not* infinitely remote, but on the contrary so near the object and the paper that in looking at them the eye may conveniently be placed as near the paper as that point of view was supposed to be, in which case the drawing will appear to the eye just as the object itself did. And it does not at all follow that the object is to be inclined to the paper, which in fact it usually is not, nor does it appear to be, as will be seen by referring to Fig. 143, or, perhaps still better, in Fig. 204, which is a perspective drawing of the same prism, in the same position with relation to the paper as in A of Fig. 200.

The process of constructing the last group, Fig. 203, involves no new principles, and the student will be able to trace the operation readily by the aid of the corresponding letters. But in regard to the first step—that is, the copying of the view C of Fig. 202—it may be well to say a few words. In constructing this view from the other two, the line $x\,x$ was drawn through c, the point nearest the observer, as a reference line from which to measure the distances from the front to the back, as $e\,g$, etc., in the top view. Now, in making the copy, it might seem a natural proceeding to draw this line in its new position in Fig. 203, and then to make the angle $x\,c\,b$ in the copy equal to $x\,c\,b$ in the original, in order to determine the direction of $c\,b$, and so on.

This is all perfectly correct, but the copying of angles in this way, though at times necessary, should be avoided when practicable, and in the present instance it may be done, and less chances of error encountered, by taking advantage of the fact that, continuing the vertical guiding lines through $h\,d$, $f\,b$, and drawing through o a parallel to $x\,x$, the view C is enclosed in a rectangle, $l\,m\,n\,o$. And the two sides $h\,d$, $f\,b$, coincide with the sides $l\,o$, $m\,n$, of the rectangle, while the other lines, $e\,g$, $a\,e$, are parallel to them.

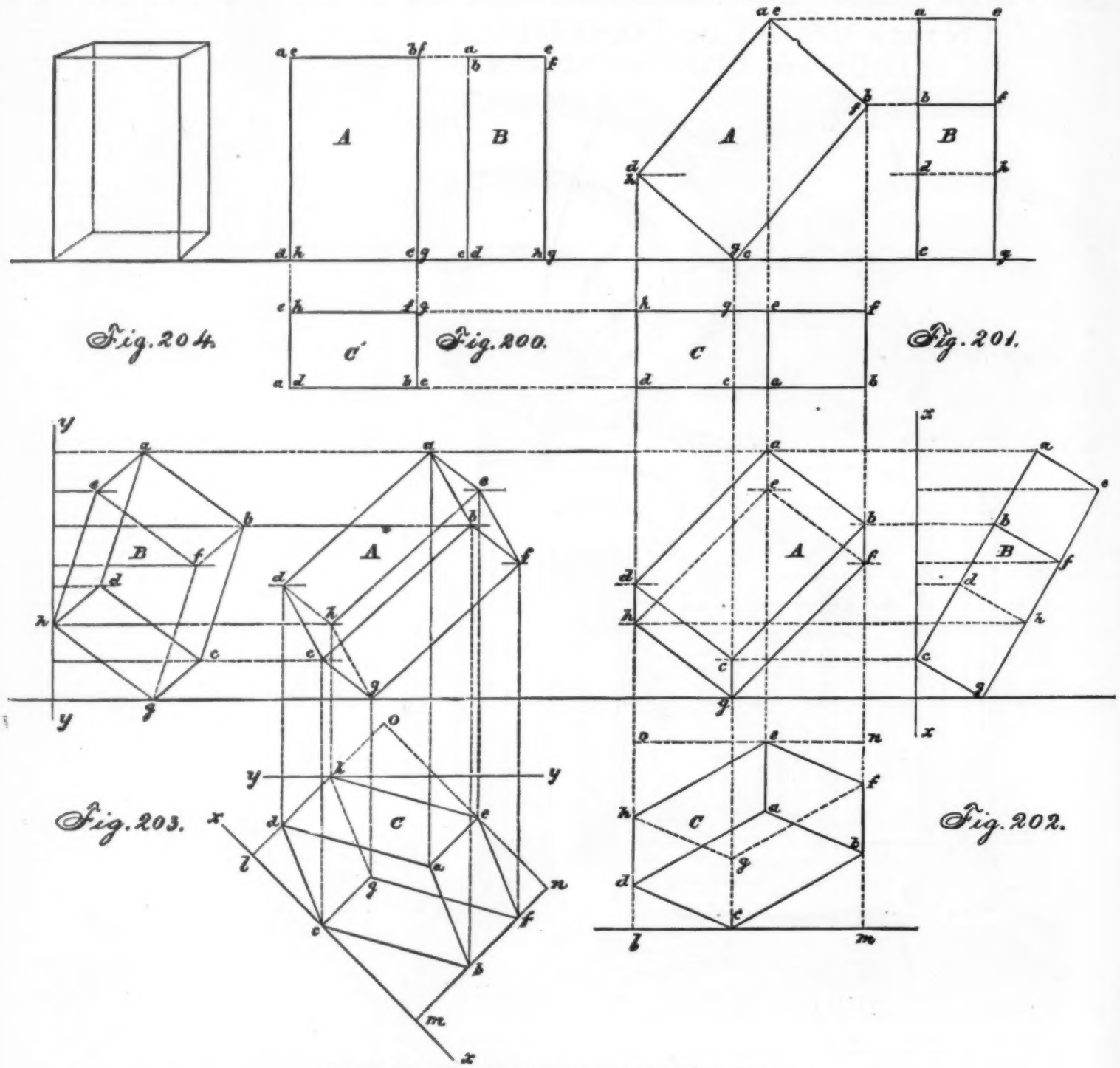
The best way to proceed, then, is first to copy the rectangle, and set off $m\,c$ and its equal $o\,s$; then set m off f and $o\,d$ equal to each other, also $m\,b$ equal to $o\,k$. Then drawing $c\,a$, $e\,g$, parallel and equal to $d\,h$ and $f\,b$, the "laying out" of the whole figure is complete; and it has been done without the construction of an angle, other than the right angles of the circumscribing rectangle. And this method has another advantage: it has been remarked before that if two lines be parallel in the object they will appear parallel in any view that is made of the object, so that a good, perhaps the best, test or check of the accuracy of the work as it progresses through the various changes of position is afforded by this parallelism, and if these lines are also equal they will appear equal too in any projection. Now, by this mode of proceeding we insure this equality and parallelism in the copy, provided that it exists in the original; we apply the check beforehand, as one may say, and make its application serve the purpose of constructing the figure. The reader will recollect that the importance of applying tests, in various ways according to the nature of the work, has been spoken of long ago. And the one just mentioned—namely, that lines which are equal and parallel in space, or in other words, in the body to which they belong, will appear equal and parallel, though not in their true length or direction, in any projection made of them on a plane surface like the paper—is of so great utility and such frequent application, that it should be firmly fixed in the mind.

We have, now, rung all the changes in regard to this matter of successive revolutions, and have at last succeeded in placing the object in the most complicated relations to the paper of which it is capable. And the method of deriving from the drawing in the original or most simple position the correct representations of the lines in any other is perfectly general. We have selected for the purpose of illustration an

object of the simple form of the rectangular prism merely because it *is* simple, and the processes are therefore more readily followed. For although these steps are not by any means complicated in themselves, yet when combined they present some difficulties to the beginner, especially in the effort required to connect distinctly the object with the drawing.

This effort of the imagination the student should always make. In looking at his drawing he should mentally see, not a series of lines only, but a solid object represented by them; by progressive exercises, beginning with objects of simple form and going gradually on to the consideration of more complex ones, this imaginative power may be trained and strengthened. A great aid also will be found in the use of a model, as previously stated; the comparison of a drawing with the object drawn will enable the student, if he will be careful to make the comparison close, exhibit to him the relations between the two in a clearer and stronger light than any thing else can possibly do. But he must not content himself with a hasty glance, merely satisfying himself that inclination, and on it take any point *c* as the centre of the direct top view C, which construct as before explained. Drawing a line through any point *d'*, perpendicular to *x x*, project upon it the visible points and lines of the base, looking at the object in the direction of the arrow, and setting off *d' c'* the given altitude, complete the front elevation. The two views thus made are evidently identical with the corresponding ones of Fig. 151, if held so as to make *x x* vertical. But *y y* being our horizontal line, we proceed to make the top view C of the inclined pyramid by drawing *z z* parallel to *y y*, and projecting *c'*, *d'*, upon it as usual, we find *c''* the projection of the vertex, and *d''* that of the centre of the base; and in short, the projection of the base of the pyramid is completed in a manner precisely similar to that adopted in the case of the inclined prism of Fig. 171; lines drawn from the angles of this irregular hexagon to the vertex *c''* complete this view, from which and the front view the third one B is made as previously described: the thicknesses required in the construction of these last two views being transferred from the manner, a perpendicular let fall from *n* in the front view, to meet *b o* in the top view, gives the two points *n*, *n* in the latter view, corresponding to *n* above. Proceeding in this manner, we find the points *p*, *p*, *r* in the top view, and since *m r* in the front view is a right line and represents the edge of a plane, the section of the pyramid in the top view will be bounded by the right lines *m n*, *n p*, *p r*, etc., forming as shown an irregular hexagon.

This, however, does not show the section in its true form or size; all the outlines are inclined and foreshortened. But it will be noted that in the top view there are two horizontal imaginary lines, *n n*, *p p*, which being viewed perpendicularly are seen in their true length; also, these lines lie in the plane of the section, and will therefore be seen in their true length if we look perpendicularly against the section. There is also in this section a line *m r*, which is not seen in its true length in the top view; but if we look perpendicularly against the plane of the section as indicated by the arrow, we shall see *m r* in the true length, and *n n* and *p p* will



LESSONS IN MECHANICAL DRAWING.—No. 23.

there is a resemblance, and that he knows the one to represent the other. He must study them together, tracing the relation of each line and surface in the object to the corresponding representations in the drawings. This will hereafter be mentioned again, as such study serves another purpose too; but at present our object is to point out the best means of developing the power of forming, with or without the aid of a drawing, a distinct mental image of any object which has been or is to be drawn. This power once well developed will render the use of a model unnecessary, and give most valuable assistance not only in reading drawings, but in making them, however complicated they may be. It is, in fact, an absolutely essential requisite to one who would derive from his acquaintance with mechanical drawing the greatest benefit.

In Fig. 205 we have a drawing of a hexagonal pyramid, placed in an inclined position. The front view is copied from the corresponding view in Fig. 151; but if we suppose that a complete drawing of the pyramid in its present position is required, we may render it complete without going to the trouble of making the three views given in Fig. 151, and then copying it, thus: Imagine that Fig. 151 had not been drawn; then draw first the indefinite axis *x x* at the required top view C. It will be noted that the arrangement of the two views A and C is very similar to that of the front view of the prism in Fig. 192, and the direct view of the oblique face of the section; and it is one which will be found of very great convenience and a great saving of labor in many cases.

Of Fig. 206 it ought not to be necessary to make any detailed explanation, as it consists simply of three views of the same pyramid in a new position, derived from the preceding one by turning it on a vertical axis, the top view being therefore copied directly; the guiding lines should enable the student to trace the remaining steps.

In Fig. 207 the same hexagonal prism is shown, cut off in a manner similar to that illustrated in the case of the prism in Fig. 192, the edge of the section in the front view appearing as the line L L.

The line *a o*, at the left of the front view, is cut at the point *m*, the line *b o* at the point *n*, and so on. Now, this line *a o* is represented in the top view by the line also lettered *a o*; *b o* of the front view corresponds to either of the two similarly lettered in the top view; and therefore, if we let fall the perpendicular *m m* from *m* in the front view to meet *a o* in the top view, the intersection with the latter line will be the projection of the point *m* in the top view. In like appear at their actual distance from each other, which is *n p* in the front view. Draw then the indefinite line *x x* parallel to L L, project *m*, *r* perpendicularly on it at *m'*, *r'*; draw through *n* and *p* two perpendiculars to *x x*, and lay off on them *n' n'* equal to *n n* of the top view, and *p' p'* equal to *p p* in the same view, each of these lines being bisected by *x x*; draw *m' n'*, *n' p'*, *p' r'*, etc.; and the resulting irregular hexagon will be the true form and dimensions of the section of the pyramid.

Now, we can develop this pyramid in the same way in which the prism was developed in Fig. 193; for its surface, considering it as complete, is made up of six equal and similar triangles, in addition to the base. Disregarding the latter, it is clear that if we cut a piece of paper into the form produced by laying six such triangles together so as to touch along the sides, and to have a common vertex, we can by folding it properly make a shell of the exact form of the pyramid. In regard to the actual size and form of either of these triangles, it is to be observed that it is not shown in either of the views of the pyramid, nor would it be were a third or side view to be constructed. In the front view, two of the edges, *a o* and *d o*, are seen in their true length; but *b o* and *c o* are not. We can very easily construct a triangle

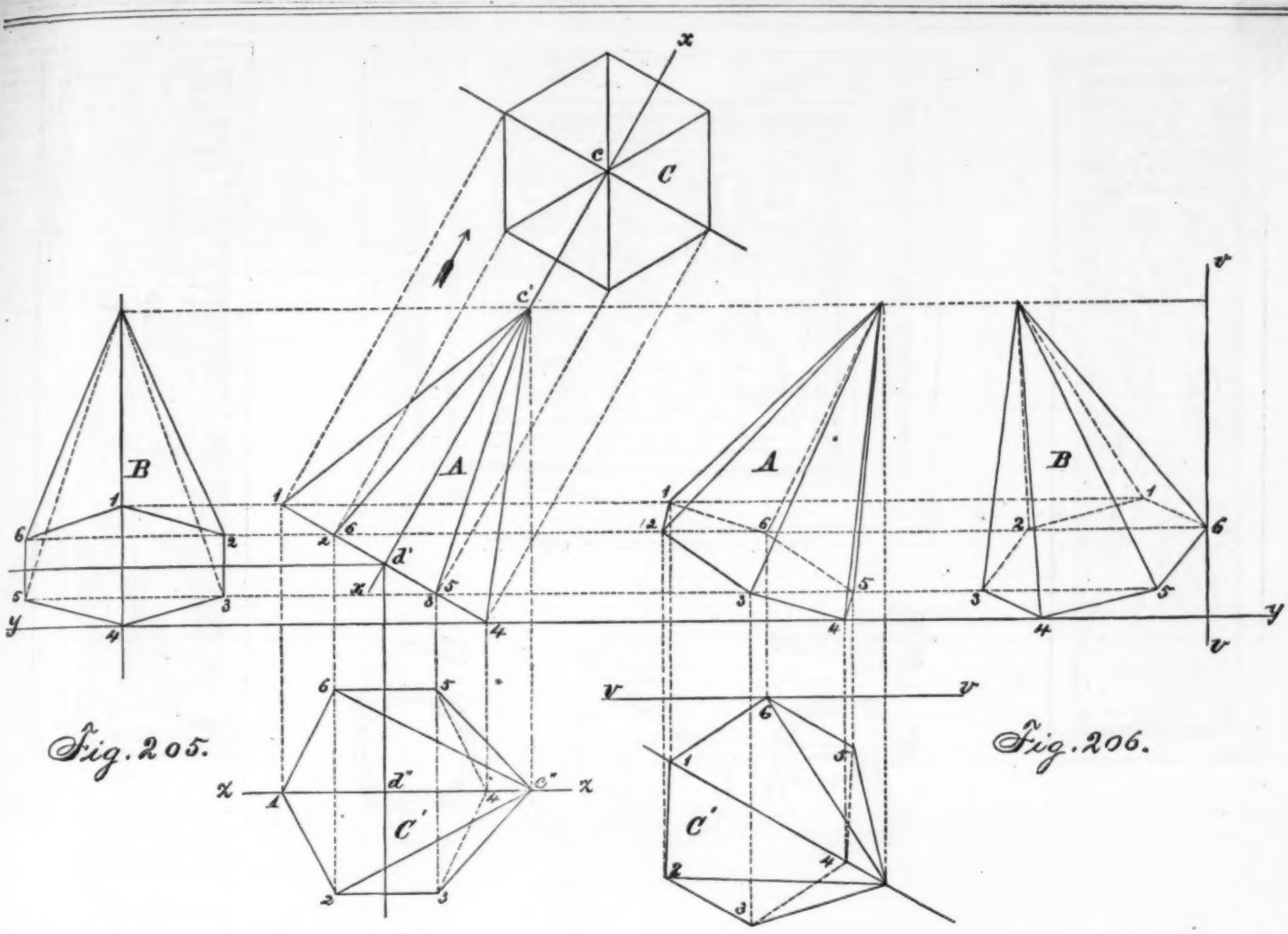


Fig. 205.

Fig. 206.

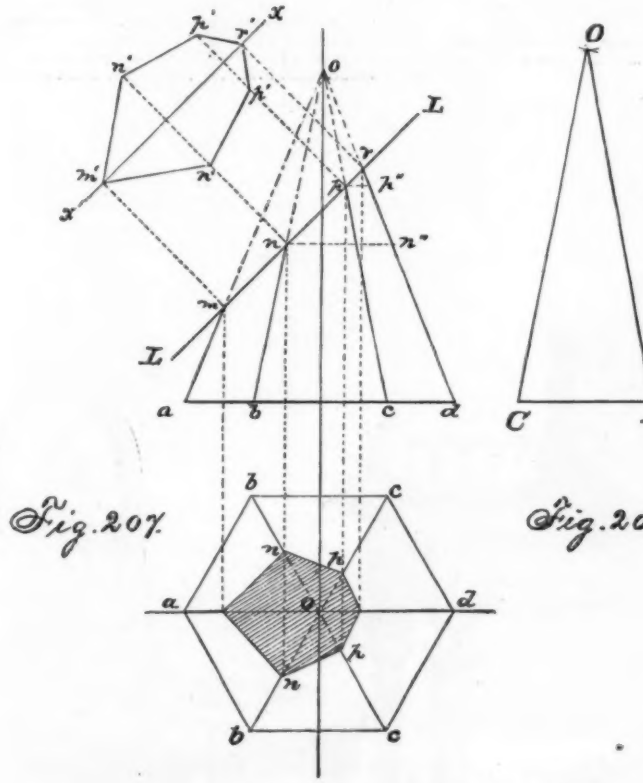


Fig. 207.

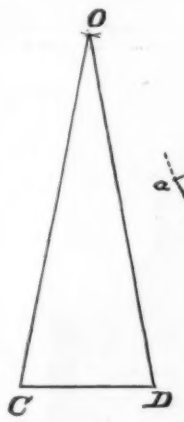


Fig. 208.

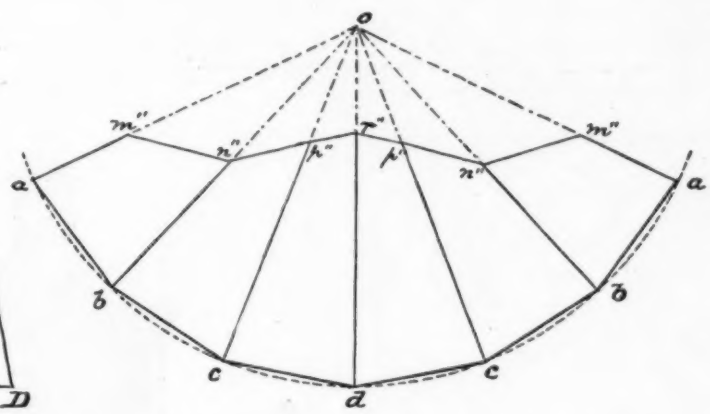


Fig. 209.

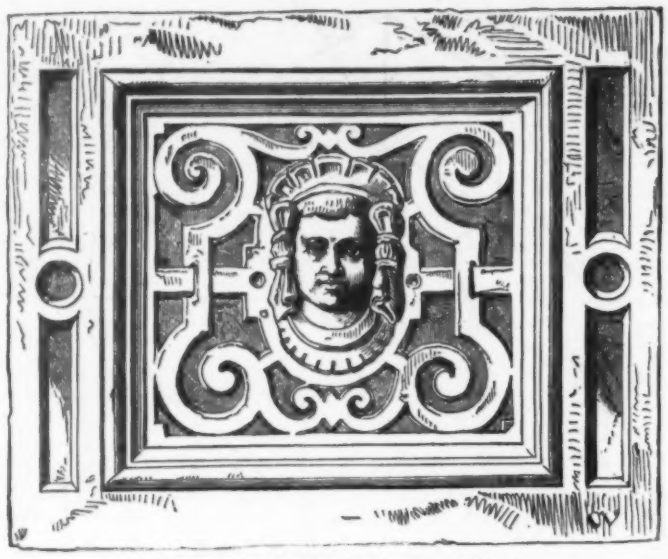
LESSONS IN MECHANICAL DRAWING.—No. 23.

which shall be of the exact form and dimensions of a face, however, as in Fig. 208: draw the base C D equal to *c d*, one of the sides of the hexagonal base of the pyramid, seen in its true length in the top view; with C and D as centres, and radius equal to *d o* in the front view—that is, equal to the true slant height of the pyramid—describe two arcs intersecting at O; then C O D is the face required.

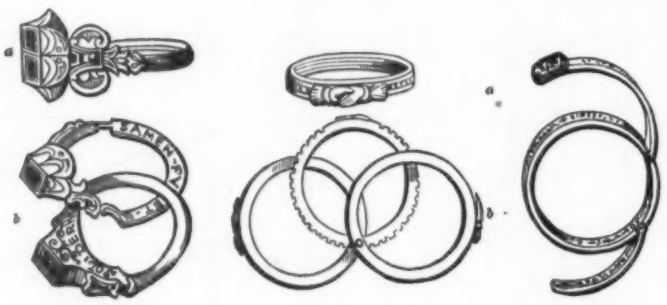
To develop the pyramid, as in Fig. 209, the best and simplest construction is to strike round any centre *o* an indefinite arc, with radius *d o* in the front view; draw any radius as *o d*, which may correspond to the edge *o d* of the front view also, and set off on each side of *d* the equal spaces *d c*, *c b*, *b a*, the chords being equal to *c d*, the side of the base of the pyramid, as before, and from the points *a*, *b*, *c* draw lines to *o*. The figure *a o a* thus formed will be of the form required, and if cut out in card-board, and cut half through on the lines *b o*, *c o*, etc., it may be folded up into a shell as before mentioned, to which, if desired, the base may be attached as it was to the shell of the prism in Fig. 193, and the model made complete.

The portion remaining if the top of the pyramid be removed, after being cut, is called a *frustum*. If it be desired to form a model of this part only, we proceed as follows: set off on *d o*, Fig. 209, a distance *d r''* equal to *d r* of the front view in Fig. 207; also on *a o*, *a m''* equal to *a m* of the same view. In that front view, the line *c o* is cut at *p* and *b o* at *n*, but neither the whole nor the part of either line is seen in its true length there, as the lines are inclined to the paper, and not viewed perpendicularly. But *d o* is thus viewed, and we know it to be of the same length as either *b o* or *c o*. If then we turn the pyramid round its axis, which is vertical, until *c* in the top view comes to *d*, we shall then see the line *c o* in its true length in the front view; and as no point changes its altitude by revolving round a vertical axis, all we have to do is to draw through *p* a horizontal line, cutting *d o* in *p''*, which will give *d p''* the true length of *c p*; and setting off this distance as *c p''* on *c o* of Fig. 209, we have another point in the outline of the shell of the frustum. In a similar manner we find *d n''* the true length of *b n*, and set it off as *b n''* on *b o* of Fig. 209; and the broken line *m'' n'' p'' r''*, etc., completes the contour of the shell. If the student desires to make such a model of the frustum complete in one piece, the upper base, of which the true form and size has been determined, may also be drawn, attached to one of the sides *m'' n''*, *n'' p''*, etc., and the same steps followed as in the case of the prism, as previously explained. The process is an interesting one, and affords good practice; which will be all the better if the conditions of the problem be varied, as by taking an octagonal or pentagonal pyramid, selecting a different angle for the plane of section, or, in a word, doing any thing except merely copying the proportions of the figure.

CARVED ORNAMENTS FROM THE WALDEMIR FOUNTAIN, RATISBON.



PANEL ORNAMENTS—17TH CENTURY.



GIMMAL FINGER RINGS.

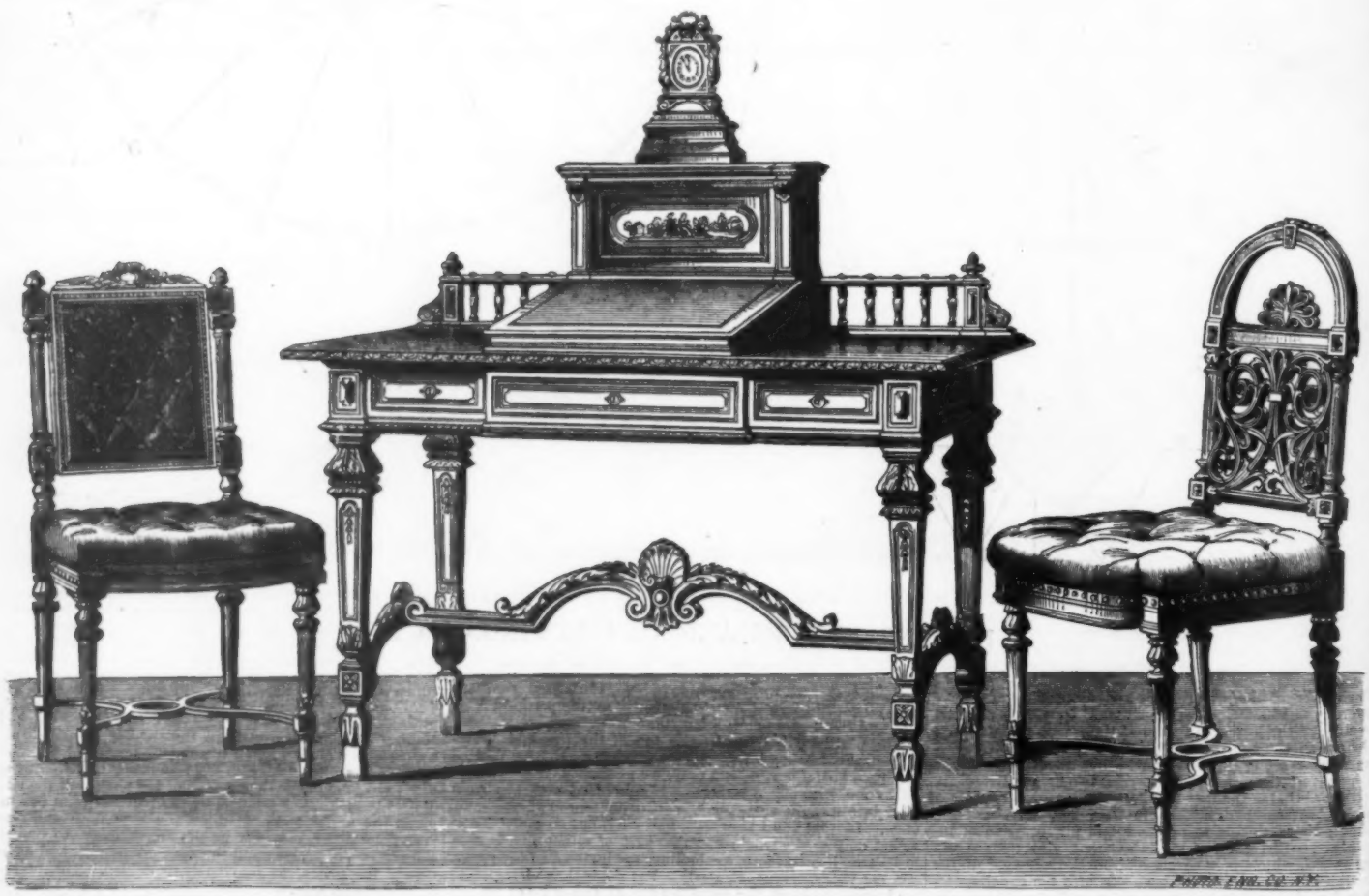
CARVED ORNAMENTS FROM THE WALDEMIR FOUNTAIN, RATISBON.

GIMMAL FINGER RINGS.

DOUBLE rings were formerly known as gemel or gimmal rings, the word being derived from the Latin *gemellus*, twins. The two making one, and, though separate, indivisible, peculiarly fitted them for wedding rings. Their structure will be best understood from the very fine specimen in the Londesborough collection, represented above at the left. The ring, as closed and worn on the finger, is shown in the uppermost figure, *a*. It is set with sapphire and amethyst, the elaborate and beautiful design enriched by colored enamels. The lower figure, *b*, shows the ring parted, displaying the inscription on the flat side of each section, which is also enriched by engraving and *niello*.

Dr. Nare remarks that "gimmal rings, though originally double, were by further refinement made triple, or even more complicated."

The ring at the right is shown (*a*) as it appears when closed; it parts into three hoops, secured on a small pivot, as seen (*b*), the toothed edge of the central hoop forming an ornamental centre to the hoop of the ring, and having two hearts in the middle; a hand is affixed to the side of the upper and lower hoop, the fingers slightly raised, so that when the hoops are brought together, they link in each other and close over the hearts, securing all firmly.—*Watchmaker and Jeweller.*



WRITING TABLE AND CHAIRS.—BY F. SCHŒNTHALER, VIENNA.—*From the "Workshop."*

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